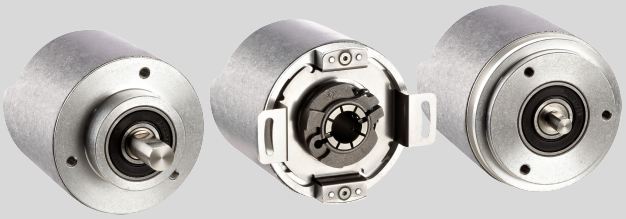
OPERATING INSTRUCTIONS

AFS/AFM60 EtherCAT®

Absolute Encoder

SICK
Sensor Intelligence.



Described product

AFS/AFM60 EtherCAT®

Manufacturer

SICK AG
Erwin-Sick-Str. 1
79183 Waldkirch
Germany

Legal information

Original document

This document is an original document of SICK AG.

Contents

1 About this document

Please read this chapter carefully before working with this documentation and the AFS60/AFM60 EtherCAT® Absolute Encoder.

1.1 Scope

NOTE

These operating instructions apply to the AFS60/AFM60 EtherCAT® Absolute Encoder with the following type codes:

- Singleturn Encoder Advanced = AFS60A-xxEx262144
- Multiturn Encoder Advanced = AFM60A-xxEx018x10

1.2 Purpose of this document

These operating instructions instruct the technical personnel of the machine manufacturer or machine operator in:

- Electrical installation
- Commissioning
- Parameterization
- Operation
- Maintenance

These operating instructions must be made available to all persons who work with the encoder.

The official and legal regulations for operating the encoder must always be complied with.

1.3 Target group

These operating instructions are intended for planning engineers, developers, and operators of plants and systems into which one or more AFS/AFM60 EtherCAT® Absolute Encoder are to be integrated. They are also intended for people who put the encoder into operation for the first time or who are in charge of maintenance.

These instructions are written for trained persons who are responsible for the installation, mounting and operation of the encoder in an industrial environment.

Only trained electricians are permitted to carry out work on the electrical system or electrical assemblies.

NOTICE

► Read the operating instructions carefully and ensure that you have understood the contents completely before you work with the encoder.

1.4 Information depth

These operating instructions contain information on the AFS60/AFM60 EtherCAT® Absolute Encoder on the following subjects:

- product features
- electrical installation
- commissioning and configuration
- fault diagnosis and troubleshooting
- conformity

These operating instructions do not contain any information on the mounting of the AFS60/AFM60 EtherCAT®. You will find this information in the mounting instructions included with the device.

They also do not contain any information on technical specifications, dimensional drawings, ordering information or accessories. You will find this information in the data sheet for the AFS60/AFM60 EtherCAT®.

Planning and using measurement systems such as the AFS60/AFM60 EtherCAT® also requires specific technical skills beyond the information in the operating instructions and mounting instructions. The information required to acquire these specific skills is not contained in this document.

When operating the AFS60/AFM60 EtherCAT®, the national, local and statutory rules and regulations must be observed.

Additional information

- www.ethercat.org
- ETG.1000, 2 ... 6: Layer protocol & service definitions
- ETG.1020, EtherCAT® Guidelines and Protocol Enhancements
- ETG.1300, EtherCAT® Indicator & Labeling specification (as per IEC 61784-2)
- ETG.2000, EtherCAT® Slave Information
- ETG.2200, EtherCAT® Slave Implementation Guide
- CiA DS-406, Profile Encoder for CANopen
- CiA DS-301, CANopen communication profile
- ET1810/1812, Slave Controller IP Core for Altera FPGA

1.5 Symbols used

NOTE
Refer to notes for special features of the device.

LED symbols describe the state of a diagnostics LED. Examples:

● Red — The red LED is illuminated constantly.

✺ Yellow — The yellow LED is flashing.

○ Green — The green LED is off.

► Take action ...

Instructions for taking action are shown by an arrow. Read carefully and follow the instructions for action.

WARNING
A warning notice indicates an actual or potential risk or health hazard. They are designed to help you to prevent accidents.

Read carefully and follow the warning notices.

1.6 Abbreviations used

CMR	Counts per Measuring Range
CNR_D	Customized Number of Revolutions, Divisor = divisor of the customized number of revolutions
CNR_N	Customized Number of Revolutions, Nominator = nominator of the customized number of revolutions
CoE	CANopen over EtherCAT®

CPR	Counts Per Revolution
DC	Distributed Clocks
EEPROM	Electrically Erasable Programmable Read-only Memory
EoE	Ethernet over EtherCAT
ESC	EtherCAT® Slave Controller
ESI	EtherCAT® Slave Information = electronic data sheet based on XML
ESM	EtherCAT® State Machine = controls the status of the EtherCAT slave
ETG	EtherCAT® Technology Group
EtherCAT®	EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany
PDO	Process Data Object
PLC	Programmable Logic Controller
PMR	Physical Measuring Range
PRS	Physical Resolution Span (per revolution)
SDO	Service Data Object

2 Safety information

This section concerns your own safety and the safety of the system operator.

► Please read this section carefully before working with the AFS60/AFM60 EtherCAT® or the machine or system on which the AFS60/AFM60 EtherCAT® is used.

2.1 General notes

DANGER

Observe the following to ensure the safe use of the AFS/AFM60 EtherCAT® as intended.

The encoder must be installed and maintained by trained, qualified personnel with knowledge of electronics, precision engineering, and controller programming. The relevant technical safety standards must be observed.

All persons entrusted with the installation, operation, or maintenance of the devices must follow the safety guidelines:

- The operating instructions must always be available and must be followed.
- Unqualified personnel must stay away from the system during installation and maintenance.
- The system must be installed in accordance with the applicable safety regulations and mounting instructions.
- The work safety regulations of the employers' liability insurance associations and trade associations in the respective country must be observed during installation.
- Failure to observe the relevant work safety regulations may lead to physical injury or cause damage to the system.
- The current and voltage sources in the encoder are designed in accordance with the applicable technical guidelines.

2.2 Intended use

The Absolute Encoder AFS/AFM60 EtherCAT® is a measuring device which is manufactured according to the recognized industrial regulations and which meets the quality requirements stipulated in ISO 9001:2008 as well as those relating to environmental management systems as defined in ISO 14001:2009.

An encoder is designed for mounting and can only be operated according to its intended function. For this reason, the encoder is not equipped with direct safety devices.

The system designer must provide measures to ensure the safety of persons and systems in accordance with the legal guidelines.

Due to its design, the AFS/AFM60 EtherCAT® may only be operated within an EtherCAT network. It is necessary to comply with the EtherCAT specifications and guidelines for setting up a EtherCAT network.

In the event of any other usage or modification to the AFS/AFM60 EtherCAT® (e.g., due to opening the housing during mounting and electrical installation) or in the event of changes made to the SICK software, any claims against SICK AG under the warranty will be rendered void.

2.3 Requirements for the qualification of personnel

The encoder must only be mounted, commissioned, and maintained by authorized personnel.

NOTE
Repair work on the encoder may only be performed by qualified and authorized service personnel from SICK AG.

The following qualifications are necessary for the various tasks:

Table 1: Authorized personnel

Task	Qualification
Mounting (see mounting instructions)	• Basic practical technical training • Knowledge of the current safety regulations in the workplace
Electrical installation and device replacement	• Practical electrical training • Knowledge of current electrical safety regulations • Knowledge of the operation and control of the devices in their particular application (e.g., industrial robots, storage and conveyor systems)
Commissioning, operation, and configuration	• Knowledge of the current safety regulations and of the operation and control of the devices in their particular application • Knowledge of automation systems • Knowledge of EtherCAT® • Knowledge of automation software

2.4 Environmental protection

Please note the following information on disposal.

Table 2: Disposal of the assemblies

Assembly	Material	Disposal
Packaging	Cardboard	Waste paper
Shaft	Stainless steel	Scrap metal
Flange	Aluminium	Scrap metal
Housing	Aluminium die cast	Scrap metal
Electronic assemblies	Various	Electronic waste

3 Product description

This chapter provides information on the special features of the Absolute Encoder AFS60/AFM60 EtherCAT®. It describes the construction and the operating principle of the device.

► Please read this chapter before mounting, installing and commissioning the device.

3.1 Specific features

Table 3: Special features of the encoder variants

Features	Singleturn encoder	Multiturn encoder
Absolute encoder in 60 mm design	■	■
Rugged nickel code disk for harsh ambient conditions	■	■
High accuracy and availability	■	■
Large ball bearing distance of 30 mm	■	■
High vibration resistance	■	■
Optimum concentricity	■	■
Compact design	■	■
Face mount flange, servo flange and blind hollow shaft	■	■
18 bit singleturn resolution (1 to 262,144 steps)	■	■
30 bit total resolution		■
12-bit multiturn resolution (1 to 4,096 revolutions)		■
Round axis functionality		■
Interface (according to IEC 61784-1)	■	■
Supports the encoder profile CiA DS-406	■	■

3.2 Operating principle of the encoder

Die Sensorik des Absolut-Encoders AFS60/AFM60 EtherCAT beruht auf absoluter Umdrehungserfassung ohne externe Versorgung und ohne Batterie. Dadurch kann der Encoder nach dem Ausschalten und anschließenden Wiedereinschalten sofort seine absolute Position ausgeben.

The Absolute Encoder detects the position and speed of rotary axes and outputs the position in the form of a unique digital numerical value. Optical detection takes place via an internal code disk.

The AFS60 is a singleturn encoder

Singleturn encoders are used when one shaft revolution must be detected absolutely.

The AFM60 is a multiturn encoder

Multiturn encoders are used when more than one shaft revolution must be detected absolutely.

3.2.1 Scalable resolution

The steps per revolution or the total resolution can be scaled and adapted to the respective application.

The steps per revolution are scalable from 1 ... 262,144 in whole numbers. The total resolution of the AFM60 must be 2^n-fold the steps per revolution. This restriction is not relevant if the round axis functionality is activated.

3.2.2 Preset function

A preset value can be used to set the position value of the encoder. I. e. the encoder can be set to any position within the measuring range. This allows, for example, the zero position of the encoder to be aligned with the machine zero point.

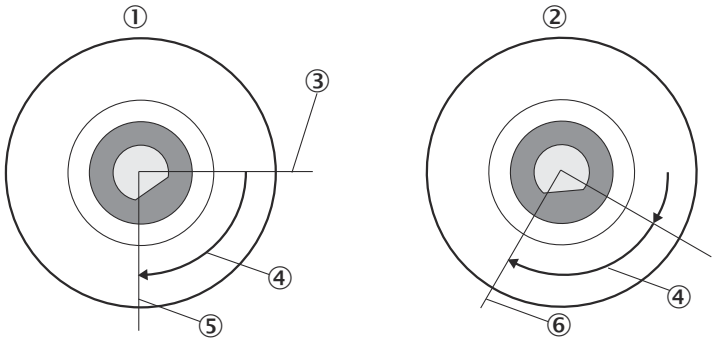


Figure 1: Setting a preset value

① Setting a preset value
② When switching on again
③ Actual position value
④ Offset
⑤ Position value after preset
⑥ Position value after switching on again

When the encoder is switched off, the offset – the delta between the real position value and the value specified by preset – is saved. When switching on again, the new calculated position value is formed from the new real position value and the offset. Even if the encoder was turned further during the switched-off state, the correct position value is output as a result.

3.2.3 Round axis functionality

The encoder supports the gear function for round axes. Here, the steps per revolution are set as a fraction (see "Round axis functionality", page 27). This allows a number that is not 2^n-fold the steps per revolution or/and a decimal number (e.g. 12.5) to be configured as the total resolution.

NOTE
The output position value is calculated with a zero point correction, the set code sequence and the entered gear parameters.

Example with transmission ratio

A rotating table for filling bottles is to be controlled. The steps per revolution are specified by the number of fillers. There are nine fillers available. 1000 steps are required for precise measurement of the distance between two fillers.

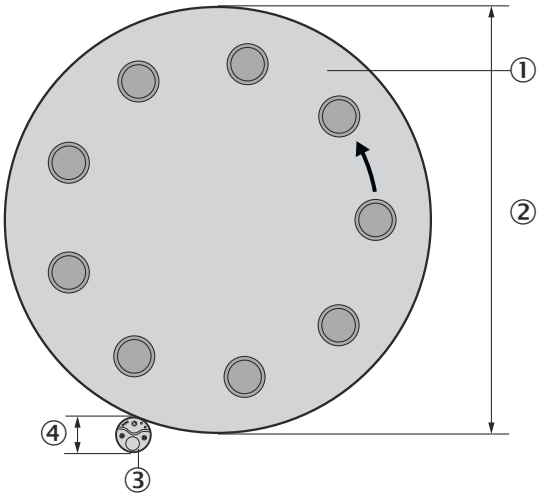


Figure 2: Example of position measurement on a rotating table with transmission ratio

① Rotating table with nine fillers
② Diameter of round table: 125 cm
③ Encoder mounted on an axis together with the drive wheel.
④ Diameter of drive wheel: 10 cm

The number of revolutions is given by the transmission ratio of the rotating table drive (125/10 = 12.5).

The total resolution is thus 9 × 1000 = 9000 steps, to be realized in 12.5 revolutions of the encoder. This ratio cannot be realized via the steps per revolution and the total resolution, since the total resolution is not 2^n-fold the steps per revolution.

The problem of the application can be solved with the round axis functionality. Here, the steps per revolution are disregarded. The total resolution and numerator and denominator of the number of revolutions are configured.

9000 steps are configured as the total resolution. The numerator of the number of revolutions is configured as 125, the denominator as 10 (125/10 = 12.5).

After 12.5 revolutions (i.e. after one complete revolution of the rotating table), the encoder reaches the total resolution of 9000.

Example without transmission ratio

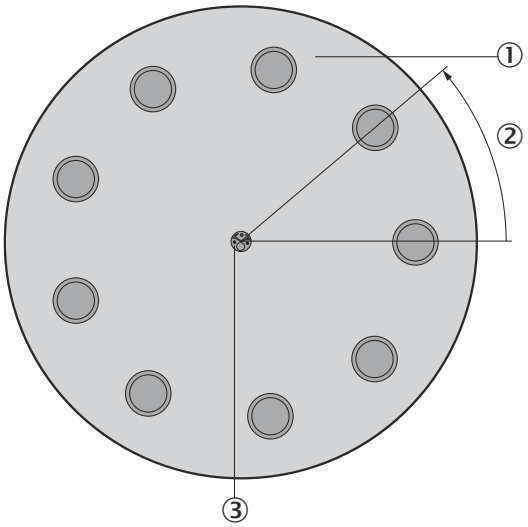


Figure 3: Example of position measurement on a rotating table without transmission ratio

① Rotating table with nine fillers
② 1000 steps
③ Encoder

The encoder is mounted directly on the shaft of the rotating table. The transmission ratio is 1:1.

The rotating table has 9 fillers. The encoder is to be configured so that it starts counting with 0 at a filler position and counts up to 999 until the next filler position.

1000 steps are configured as the total resolution.

1 is configured as the numerator of the number of revolutions, 9 as the denominator (1/9 revolutions = 1000).

After 1/9 revolutions of the encoder shaft there are 1000 steps, then the encoder starts counting again at 0.

3.2.4 Electronic cam mechanism

An electronic cam mechanism can be configured using the encoder. Two so-called CAM channels with up to eight cam switching positions are supported (①). This is a limit switch for the position.

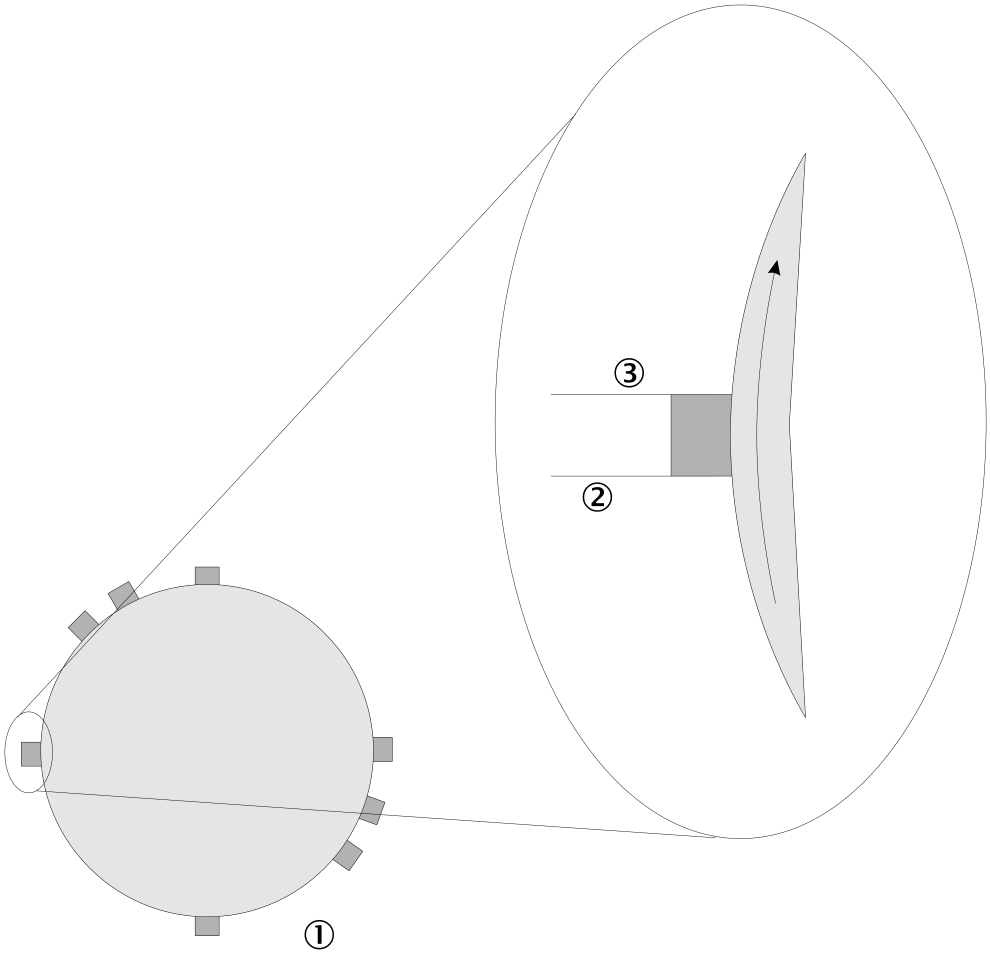


Figure 4: Example electronic cam mechanism

Among other parameters, each cam has parameters for the lower switching point (②) and the upper switching point (③), which can be configured via EtherCAT (see "Electronic cam mechanism", page 27).

3.3 Integration in EtherCAT®

3.3.1 EtherCAT® topology

EtherCAT supports a large variety of topologies such as line, tree, ring, star and their combinations.

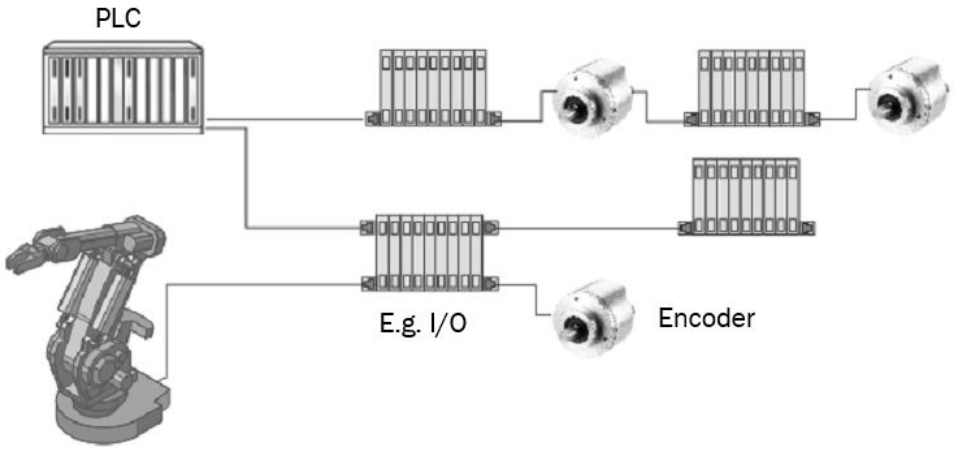


Figure 5: EtherCAT topology

For this reason the AFS60/AFM60 EtherCAT® has two Ethernet interfaces for integration in an EtherCAT topology.

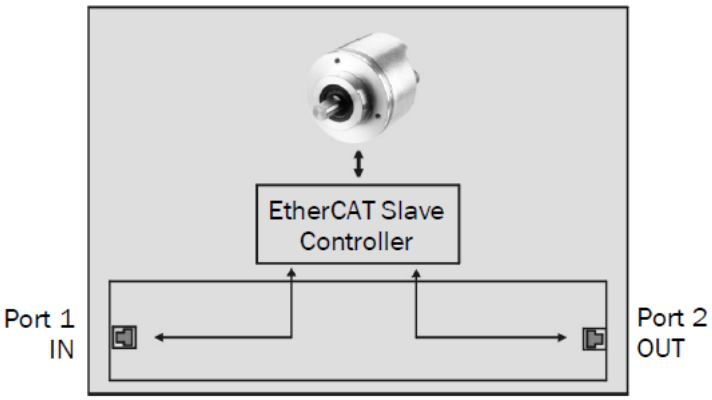


Figure 6: Two Ethernet interfaces on the encoder

An EtherCAT connection comprises to a large extent standardized Ethernet components. The slaves (e.g. the AFS60/AFM60 EtherCAT®) have an **EtherCAT® Slave Controller** for the communication with the master.

The EtherCAT® Slave Controller in the AFS60/AFM60 EtherCAT® reads the output data for the encoder and writes the input data for the PLC while the telegram is passing through. The process is implemented in hardware in the EtherCAT® Slave Controller and is therefore independent of the software cycle times of the protocol stack or the processor's performance.

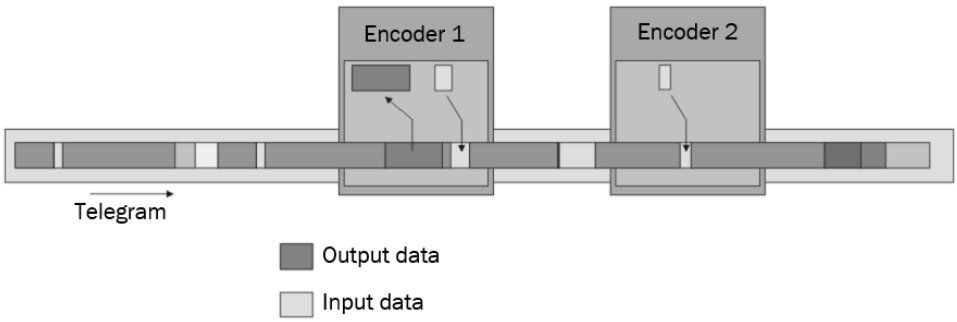


Figure 7: Passage of the EtherCAT telegram

The last EtherCAT slave in the segment sends back the already completely processed telegram so that it is sent to the controller — as a quasi reply telegram.

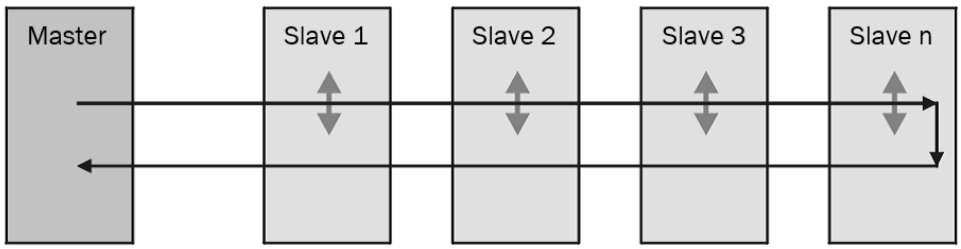


Figure 8: Returning the EtherCAT telegram

3.3.2 EtherCAT® telegram in the Ethernet frame

EtherCAT is based on the standard Ethernet frame. This contains the Ethernet header, the Ethernet data and the Ethernet trailer. The EtherCAT telegram is transported directly in the Ethernet data using a specially standardized EtherCAT frame.

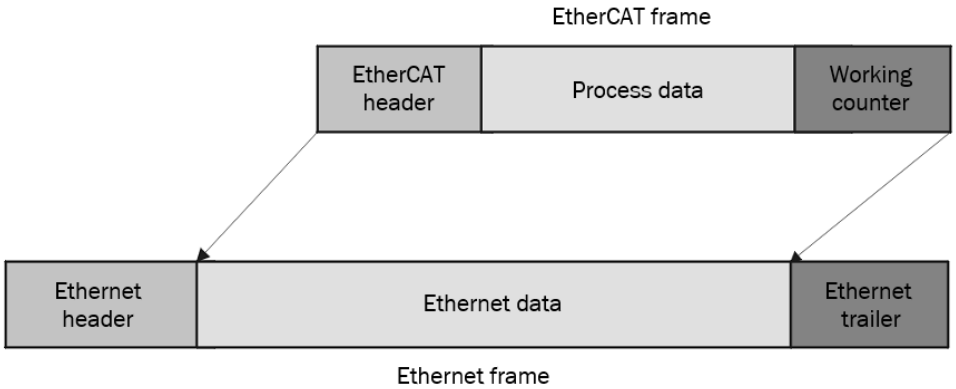


Figure 9: EtherCAT frame in the Ethernet frame

Data in the form of process data are exchanged between the master and slaves in the Ethernet frame. Each telegram has an address that refers to a specific slave or several slaves. The combination of data and address form an EtherCAT telegram.

- An Ethernet frame can contain several EtherCAT telegrams.
- Several Ethernet frames may be necessary for all the EtherCAT telegrams for a control cycle.

Each bus user has an addressable memory area of 64 kbyte in the telegram; data can be read, written or read and written simultaneously.

3.3.3 CANopen over EtherCAT® (CoE)

EtherCAT only defines a new protocol for the transport layer. It does not define its own user or device protocol. EtherCAT is able to transmit various already existing, tried and tested user protocols and device protocols via the EtherCAT protocol (tunneling).

For drive technology, e.g. CANopen over EtherCAT® (CoE) is relevant. This protocol is supported by the AFS60/AFM60 EtherCAT®. The CoE protocol makes it possible to use all CANopen profiles — and as a consequence also to utilize the encoder profile DS-406. You can see which objects of the encoder profile are implemented in the AFS60/AFM60 EtherCAT® (see "Overview of the encoder profile-specific objects", page 39).

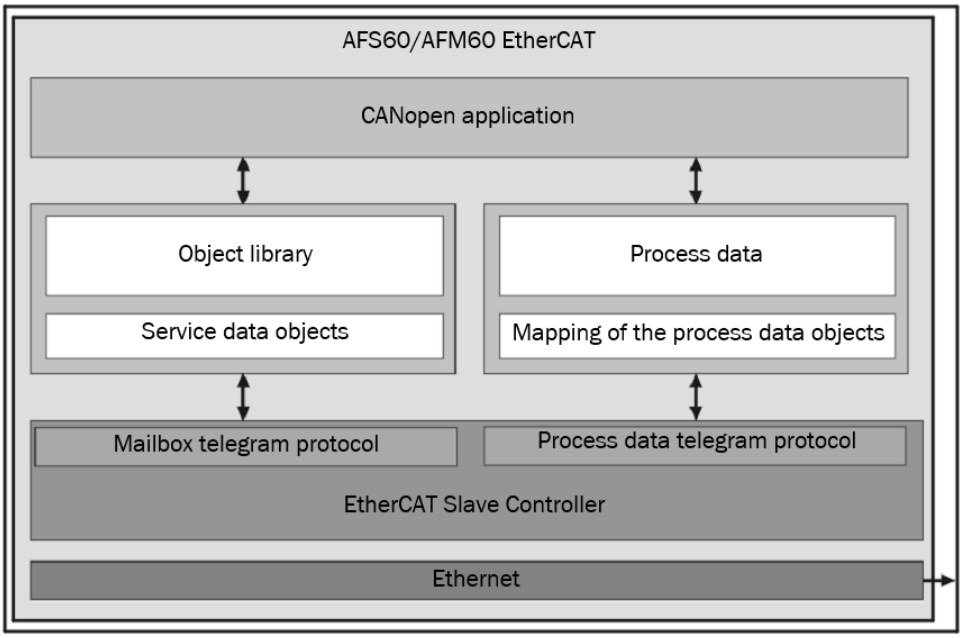


Figure 10: CANopen over EtherCAT®

The EtherCAT protocol provides two different transfer rates for the transmission. These two transfer rates are the mailbox telegram protocol for acyclic data and the process data protocol for the transmission of cyclic data.

- Mailbox telegram protocol
  This transfer type is used to transmit the service data objects (SDO) defined under CANopen. The objects are transmitted in EtherCAT in SDO frames. The service data objects form the communication channel for the transmission of device parameters (e.g. programming the encoder resolution). These parameters are transmitted acyclically (e.g. only once on starting the network).
- Process data telegram protocol
  This type of transfer is used to transmit the process data objects (PDO) defined under CANopen that are used to exchange cyclic data. The objects are transmitted in EtherCAT in PDO frames. The process data objects are used for the quick and efficient exchange of real time data (e.g. I/O data, set or actual values).

3.3.4 ESI file

To be able to simply interface EtherCAT slave devices to an EtherCAT master, an ESI file must be available for each EtherCAT slave device. This file is in XML format and contains information on the following features of the AFS60/AFM60 EtherCAT®.

- information on the manufacturer of the device
- name, type and version number of the device
- type and version number of the protocol used for this device
- default parameters of the AFS60/AFM60 EtherCAT® and default configuration of the process data

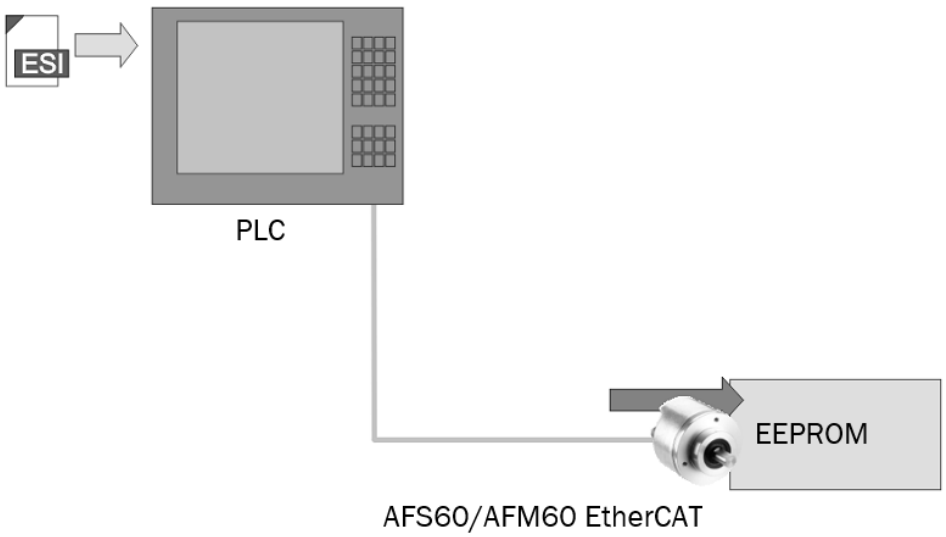


Figure 11: Integration via ESI file

- Copy the ESI file **SICK-AFx_vX-xxx** in the TwinCAT® folder to the folder **TwinCAT\3.1\Config\Io\EtherCAT**.
- Restart the TwinCAT® system manager.
- Add the encoder in the device tree as a box.
- Then place the TwinCAT® system manager in the configuration mode.

NOTE
A detailed description of the configuration see "System configuration", page 65.

3.4 Configurable functions

The AFS60/AFM60 EtherCAT® is configured in the configuration tool TwinCAT® using various objects. The most important objects for the configuration of the functions are listed in the following. A complete list of the objects see "Object library", page 30.

CAUTION

When parameterizing the encoder, make sure that there are no persons in the hazardous area of a system!

All parameter changes directly affect the operation of the encoder. The position value can therefore change during parameterization, e.g., if a preset is executed or the scaling is changed. This could cause an unexpected movement that could endanger people or damage the system or other objects.

NOTE

The parameterization carried out is only written to the volatile memory in the encoder and is therefore not permanently saved. After a restart, the default settings stored in the encoder EEPROM are loaded. There are 2 options for permanently adopting the parameterization:

1. Expand the startup list to include the parameters to be changed.
2. Execute a Save command in the encoder to write the changed parameters to the encoder EEPROM.

Startup list

Recommended procedure:

If the parameters to be changed are added to the startup list, the corresponding entries are written to the encoder when the encoder is restarted. The advantage of this is that when an encoder is replaced, the individual settings are written directly to the new encoder and therefore no new encoder parameterization is required.

Example of default startup list (the existing 4 entries must not be deleted):

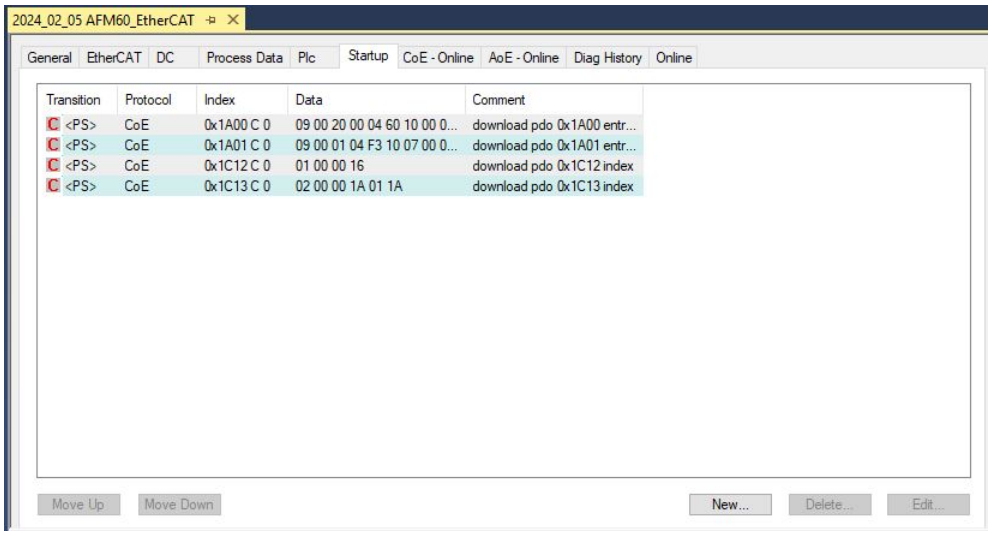


Figure 12: Example of default startup list

Example of startup list with changed scaling:

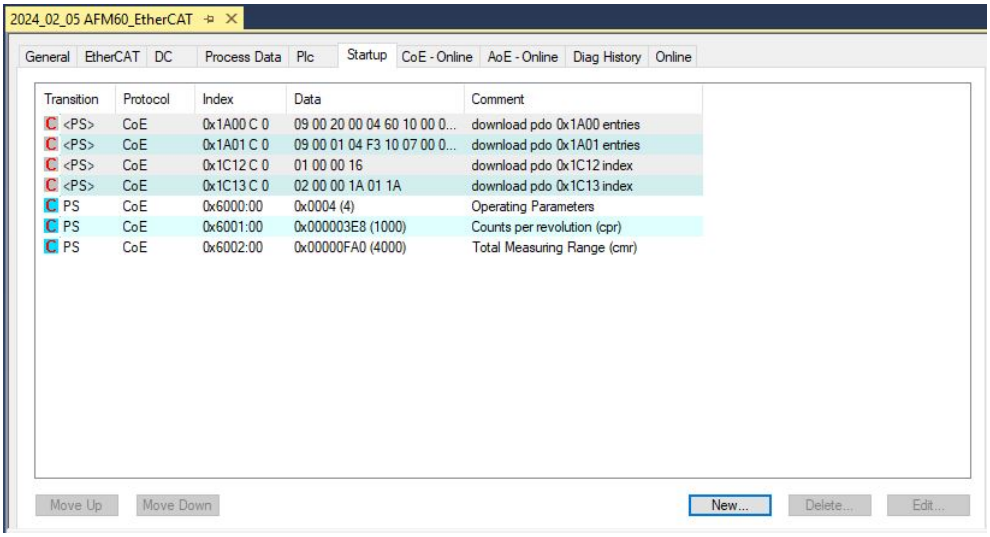


Figure 13: Example of startup list with changed scaling

Save command (object 1010h)

After parameterizing the encoder, it must be set to "Pre-Operational" mode via the control unit. The Save command must then be executed see "Object 1010h – Save Parameter", page 32

As the parameter changes are written directly to the encoder EEPROM, the settings are lost after an encoder replacement. A new encoder must then be parameterized again and a Save command must be sent.

3.4.1 Scaling parameters

The scaling parameters are configured using objects 6000h, 6001h and 6002h.

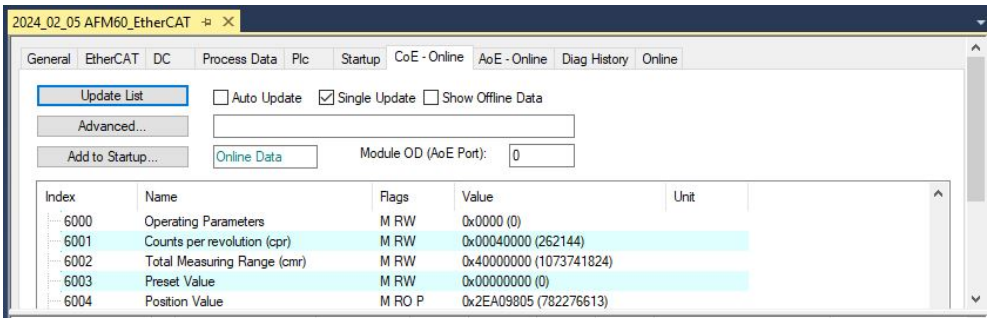


Figure 14: Objects 6000h, 6001h and 6002h in TwinCAT®

6000h – Operating parameters

Object **6000h** (see table 31, page 40) is used to configure the parameters **Support additional error code, scaling** and **Code sequence** . The object is parameterized via a 16-bit wide bit sequence.

Example:

Bit 0 = Code sequence ccw = 1

Bit 2 = Scaling on = 1

Table 4: Example of binary code

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Value	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1

The binary value must be converted into a hexadecimal value and entered in the configuration dialog.

101b = 5h

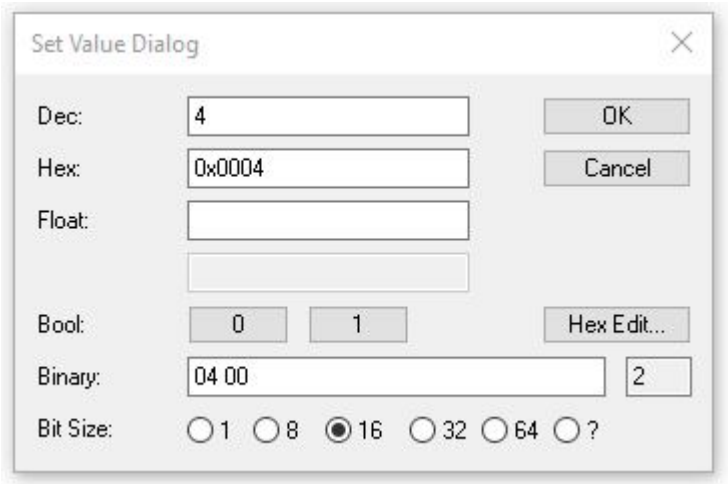


Figure 15: Example of parameterization of object 6000h

Scaling

Scaling allows the resolution per revolution or the total resolution to be scaled.

NOTE
The values entered for the resolution or total resolution are only adopted if the **Scaling** parameter is configured to **1** .

Code sequence

The code sequence determines at which direction of rotation, starting from a viewing direction on the shaft, the position value increases.

- Clockwise (cw) = increasing position value when the shaft rotates clockwise
- Counterclockwise (ccw) = increasing position value when the shaft rotates counterclockwise

6001h – Counts Per Revolution (CPR)

Object **6001h** (see table 33, page 41) is used to configure the resolution per revolution.

NOTE
The parameter is not used if the round axis functionality is activated.

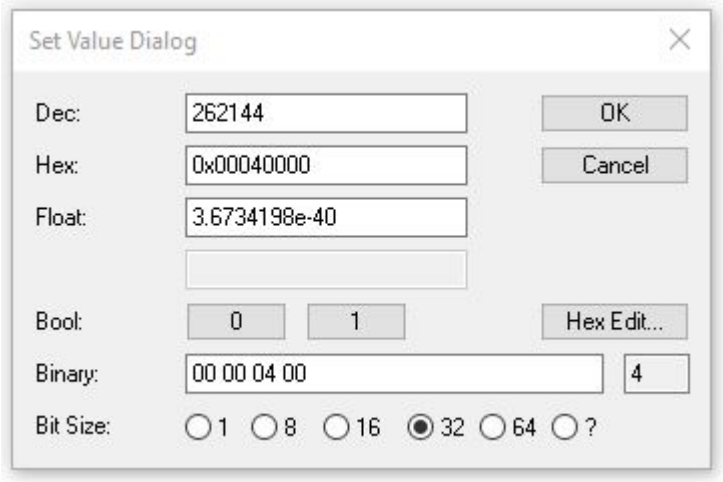


Figure 16: Example of parameterization of object 6001h

The resolution of the AFS60/AFM60 EtherCAT® Advanced is max. 262,144 increments per revolution. The resolution is scalable on an integer basis from 1 ... 262,144.

6002h – Total Measuring Range (CMR)

Object **6002h** (see table 34, page 41) is used to configure the overall resolution.

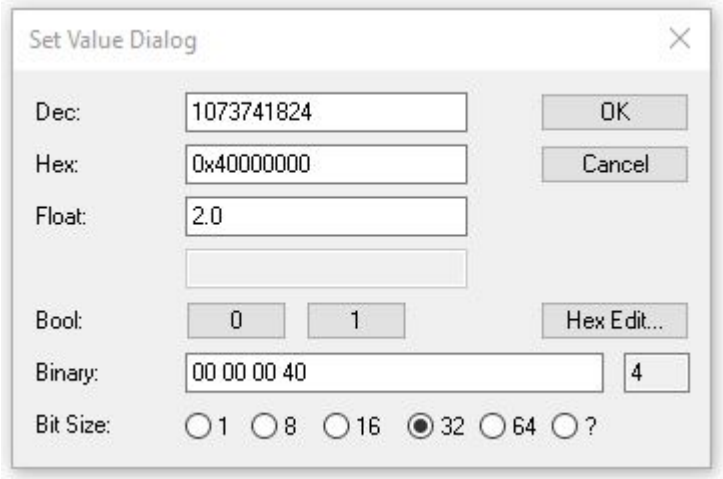


Figure 17: Example of parameterization of object 6002h

The total resolution, i.e. the measuring range of the AFS60 EtherCAT®, is max. 262,144 increments. The total resolution of the AFM60 EtherCAT® is max. 1,073,741,824 increments.

The total resolution must be 2^n times the resolution per revolution.

NOTE

This restriction is not relevant if the round axis functionality is activated.

Table 5: Examples for total resolution

Resolution per revolution	n	Total resolution
1,000	3	8,000
8,179	5	261,728
2,048	11	4,194,304

3.4.2 Preset function

The position value for an encoder can be set with the aid of the preset function. I.e. the encoder can be set to any position within the measuring range.

NOTE

- Only set a preset value when the encoder is at standstill.
- The preset value must lie within the measuring range configured.

CAUTION

Before triggering the preset function, check whether there is a hazard from the machine or system in which the encoder is integrated!

The preset function results in a change in the position value output by the encoder. This change could cause an unexpected movement that may result in a hazard for persons or damage to the system or other items.

The preset value can be set with the aid of the following methods:

- Using acyclic communication (SDO) with the object 6003h.
- Using cyclic communication (PDO) with the object 2000h. The value from object 2005h is used.
- Via the Preset pushbutton (see "Settings on the hardware", page 63). The value from object 2005h is used.

Acyclic communication (SDO)

The preset value is transferred directly to the encoder using the object **6003h – Preset Value** (see table 35, page 41). The encoder immediately adopts the preset value that is written to the object as the new position value.

The function is available if the EtherCAT® state machine is in the Operational or Preoperational status.

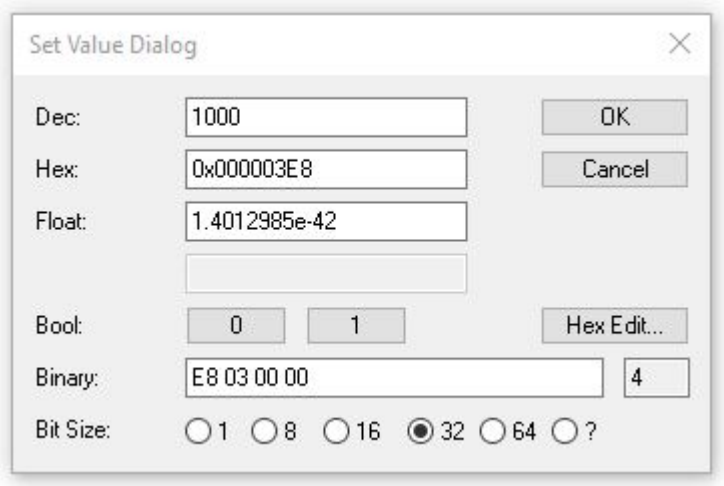


Figure 18: Example for the parameterization of object 6003h

Cyclic communication (PDO)

The preset value is initially transferred to the encoder using the object **2005h – Configuration Preset Value** (see table 73, page 52).

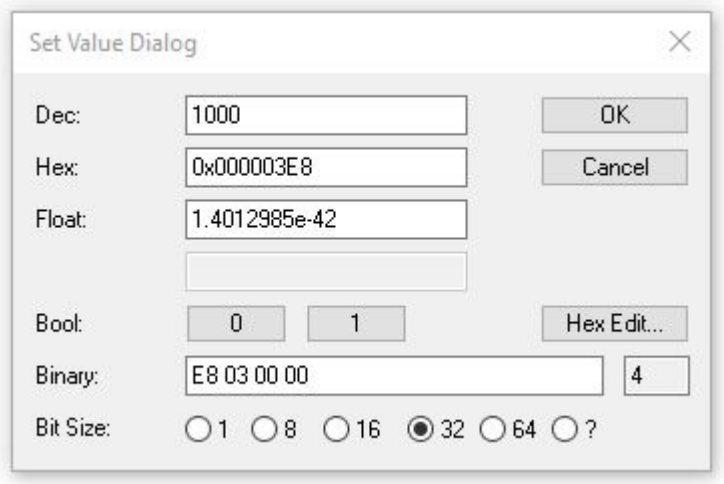


Figure 19: 0001 1000 0000 0000 bExample for the parameterization of object 2005h

The function is triggered using the object **2000h – Control Word 1** (see table 67, page 50).

The function is available if the EtherCAT® state machine is in the Operational status.

The object is configured using a bit sequence 16 bits wide.

Example:

Bit 12 = Preset is set = 1

Bit 11 = Preset-Modus Shift Positive = 1

Table 6: Example for binary code

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Wert	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0

The binary value must be converted into a hexadecimal value and entered in the configuration dialog box.

0001 1000 0000 0000 b = 1800h

3.4.3 Cyclic process data

The cyclic process data are defined using the process data objects **1A00h** and **1A01h** (see "PDO mapping objects", page 35). Nine objects can be mapped in nine subindices.

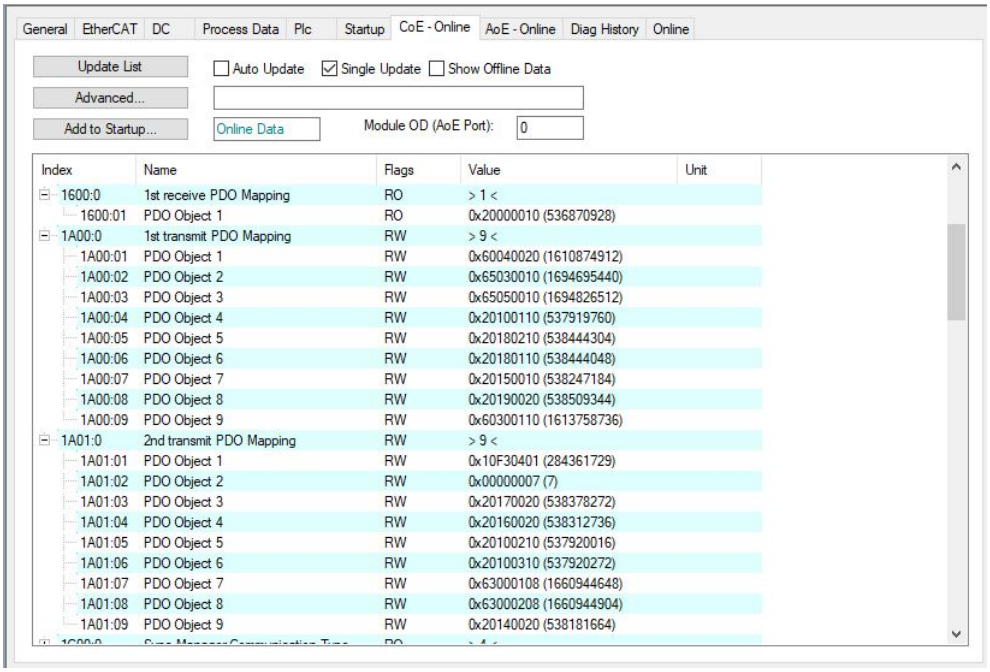


Figure 20: Default parameterization of object 1A00h

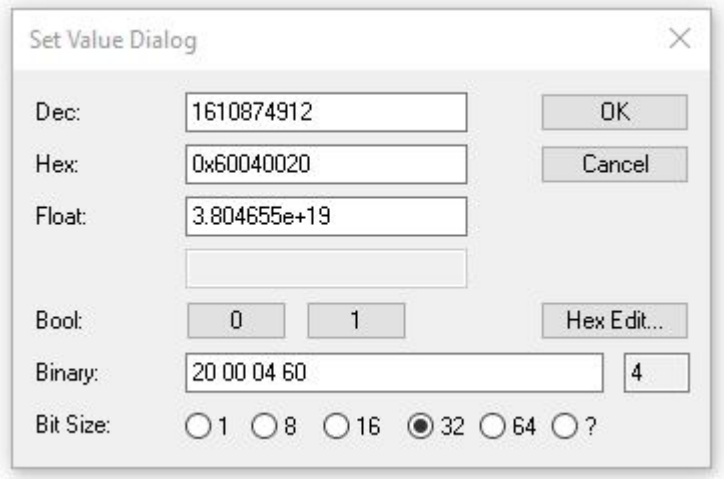


Figure 21: Example for the parameterization of subindex 1A00.01h

The object to be integrated is entered with its object number, the subindex and the data length (see table 25, page 36).

Example:

60040020h

Object = 6004h

Subindex = 00h

Data length = 20h (32 bit)

3.4.4 Synchronization

The default setting for the synchronization is synchronization using SM events; the setting can be changed to synchronization using DC sync events for high accuracy applications. This setting is made using the objects **1C32h** or **1C33h – SM-2/-3 Output Parameter** (see table 29, page 38).

► Select the required operating mode (SM or DC) in your control system.

3.4.5 Speed measurement

The speed measurement is configured using the object **2002h – Speed Calculation Configuration** (see table 70, page 51).

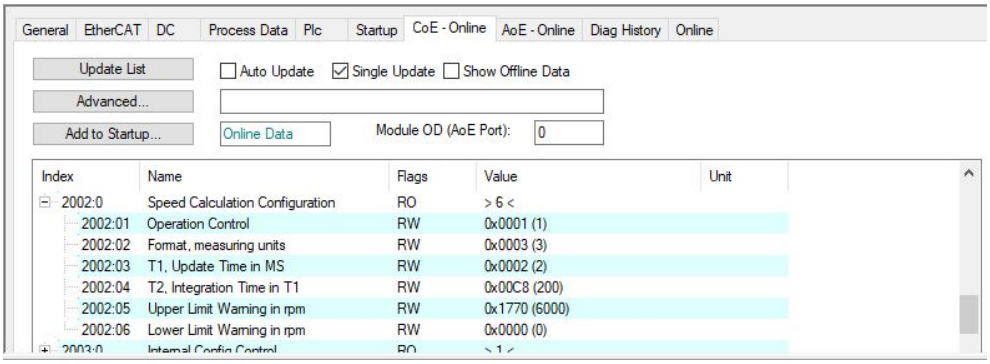


Figure 22: Subindices of object 2002h

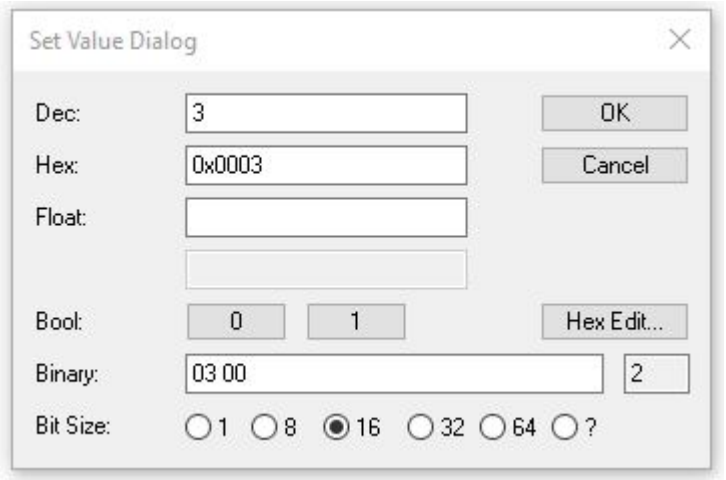


Figure 23: Example for the parameterization of subindex 2002.02h

Using the subindex **2002.02h – Format: Measuring Units** you can define the units in which the speed is transmitted.

Possible units are:

- cps
- cp10ms
- cp100ms
- rpm
- rps

The factory setting is 3h = rpm.

Using the other Subindices you can configure the refresh time as well as the maximum and minimum speed (see table 70, page 51).

3.4.6 Round axis functionality

The Round axis functionality removes the restriction that the total resolution must be 2^n times the resolution per revolution. The shaft is considered as an **endless shaft.**

The resolution per revolution is not configured directly, instead the nominator and divisor for the number of revolutions are defined.

The Round axis functionality is configured using the object **2001h – Endless-Shaft Configuration** (see table 69, page 50).

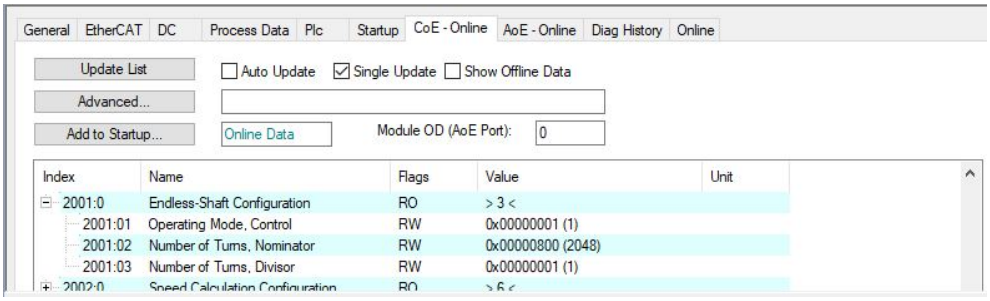


Figure 24: Subindices of object 2001h

The total measuring range can be scaled from 1 ... 1,073,741,824 as an integer.

The nominator (2001.02h – Number of Revolutions, Nominator) can be scaled from 1 ... 2,048 as an integer. The default factory setting for the nominator is 2,048.

The divisor (2001.03h – Number of Revolutions, Divisor) can be scaled from 1 ... 2,048 as an integer. The default factory setting for the divisor is 1.

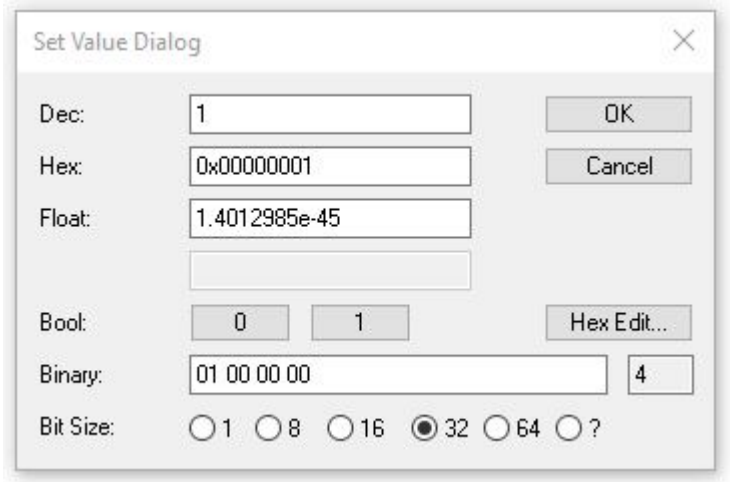


Figure 25: Example for the parameterization of subindex 2001.03h

3.4.7 Electronic cam mechanism

An electronic cam mechanism can be configured using the encoder. Two so-called CAM channels with up to eight cam switching positions are supported. This is a limit switch for the position.

The electronic cam mechanism is configured using several objects (see "Detailed information on the electronic cam mechanism (CAM)", page 42).

The cams are enabled using the object **6301h –CAM Enable Register,** the polarity is defined using the object **6302h – CAM Polarity Register**.

Each position parameter is defined by its minimum switching point (objects **6310h** to **6317h**), its maximum switching point (objects **6320h** to **6327h**) and its switching hysteresis (objects **6330h** to **6337h**).

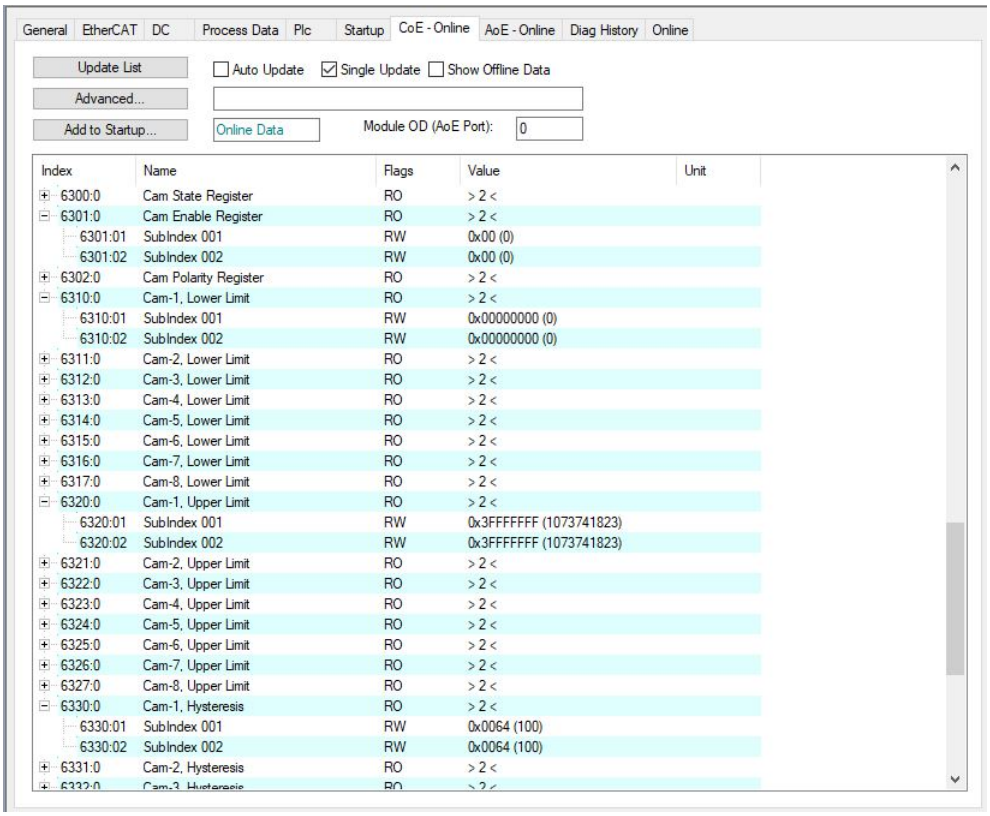


Figure 26: Objects for the electronic cam mechanism

3.5 Operating modes and synchronization

3.5.1 EtherCAT® State Machine

As in every EtherCAT slave, an EtherCAT® state machine is implemented in the AFS60/AFM60 EtherCAT®. This assumes the following status:

Table 7: Status of the EtherCAT® State Machine

Status	STAT status LED	Description
Initializing	Off	Initialization starts, saved values are loaded.
Pre-Operational	Flashing green (200 ms)	The encoder is ready for parameterization, acyclical communication via SDO can take place.
Safe operational	Flashing green (200/1,000 ms)	The EtherCAT master reads the position values from the encoder via PDO and SDO.
Operational	Green	The EtherCAT master and encoder exchange data via PDO and SDO in real time.

The PLC usually carries out the start-up in the following sequence:

Initializing, Pre-Operational, Safe-Operational, Operational.

If the TwinCAT® software from Beckhoff Automation GmbH is used, these steps can be carried out automatically in the system manager or individually if required. If a control program is started in the TwinCAT®PLC, the start-up is executed automatically.

- The status of the EtherCAT® State Machine is displayed by the STAT status LED (see "NMOD, STAT and Encoder status LEDs", page 71).
- Errors during the transition between the states of the EtherCAT® state machine are transmitted to the master via so-called emergency messages (see "EtherCAT® specific errors", page 74).

3.5.2 Synchronous operating modes

In the **Operational** status the position is always determined in synchronism with the PSDI cycle for the bus communication. The default setting for the synchronization is synchronization using SM events; the setting can be changed to synchronization using DC sync events for high accuracy applications.

NOTE

- At cycle times in the range from 125 µs ... 480 µs the encoder status LED flashes green.
- If the system cycle time is outside the encoder's range limits (125 µs ... 100,000 µs), the encoder signals a bus communication error and the STAT status LED illuminates red (see "NMOD, STAT and Encoder status LEDs", page 71).

3.5.3 Cycle times

The AFS60/AFM60 EtherCAT® supports the following data exchange modes:

- standard data exchange
- fast data exchange

Standard data exchangeFast data exchange

In the standard data exchange the encoder supports process data cycle times of ≥ 480 µs.

A new position value is determined every 480 µs for the standard data exchange. This time is required to convert the measured value acquired optically by the sensor, to scale the value and to process it for EtherCAT.

If shorter cycle times are necessary, although the encoder can be used with this cycle, a newly calculated position can only be provided every 2nd, 3rd or 4th cycle. The position value calculated previously is sent for the other cycles.

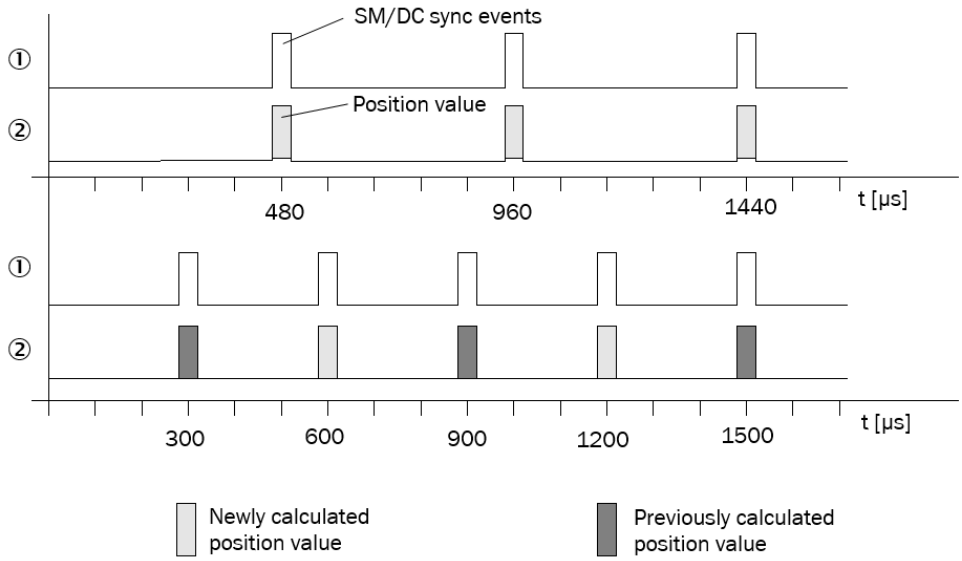


Figure 27: Standard data exchange

① process data cycle of the master
② cycle of the encoder

NOTE
Data exchange via SDOs not possible in the Operational status!
In the fast data exchange the encoder's EtherCAT® state machine must be switched back to the Pre-Operational status to be able to process SDOs.

In fast data exchange the encoder supports process data cycle times of ≥ 240 µs.

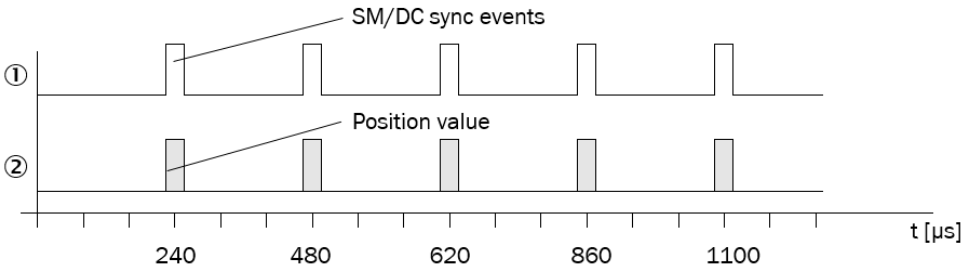


Figure 28: Fast data exchange

① process data cycle of the master
② cycle of the encoder

Using the object **6000h** (see table 31, page 40) the parameter **Fast Data Exchange Mode** is configured.

3.6 Object library

The AFS60/AFM60 EtherCAT® contains various types of objects:

- standard objects with 1000 series object numbers
- manufacturer-specific objects with 2000 series object numbers
- encoder profile-specific objects with 6000 series object numbers

3.6.1 Nomenclature

Table 8: Nomenclature of the access types and data types

Abbreviation	Meaning
R	Read = read only
R/W	Read/Write = read and write access
STRG	String = character string of variable length
BOOL	Boolean = logical value 0 or 1
INT	Integer value (negative/positive) (e.g. INT-8 = −128 ... +127)
UINT	Unsigned Integer = integer value (e.g. UINT-32 = 0 ... 4.294.967.295)
Array	Series of data of one data type (e.g. Array [UINT-8] = character string of data type UINT-8)
Record	Series of data with different data types (e.g. UINT-8, UINT-32, UINT-32, UINT-16)

3.6.2 Overview of the standard objects

Table 9: Implemented standard objects

ObjectSubindex	Access	Data type	Designation
1000h	R	UINT-32	Device Type
1008h	R	STRG	Device Name
1009h	R	STRG	Hardware Version Number
100Ah	R	STRG	Software Version Number
1010h .0 1	R/W	Array UINT-32	Save Parameters
1011h .0 1	R/W	Array UINT-32	Load/Restore Parameter
1018h .0 4	R	Record	Identity
10F3h .0 ... .25	R/W	Record	Diagnosis History
1600h .0 and .1	R/W	Record	1st Receive (Rx) PDO mapping
1A00h .0 9	R/W	Record	1st Transmit (Tx) PDO mapping
1A01h .0 9	R/W	Record	2nd Transmit (Tx) PDO mapping
1C00h .0 4	R	Array UINT-8	Sync Manager Communication Type
1C12h .0 2	R	Record	Sync Manager PDO Mapping for Sync channel 2
1C13h .0 2	R	Record	Sync Manager PDO Mapping for Sync channel 3
1C32h .0 ... .15	R	Record	Sync Manager parameter
1C33h .0 ... .15	R	Record	Sync Manager parameter

3.6.3 Detailed information on the standard objects

NOTE
In the following only those objects are described in detail for which the content is not clear from the overview (see table 9, page 31).

Objekt 1000h – Device Type

This object specifies the device type and the device profile implemented.

Table 10: Object 1000h

Object	Access	Data type	Designation	Data values
1000h	R	UINT-32	Device Type	see table 11, page 32

Table 11: Object 1000h – details

Bit	Description	Data values
31 ... 24	The device type is output in the bits 31 ... 16.	**01h** Singleturn encoder **02h** Multiturn encoder
23 ... 16		
15 ... 8	The device profile supported is output in the bit 15 ... 0.	**01.96h** Device profile = Encoder
7 ... 0		

Object 1008h – Manufacturer Device Name

The object contains the device name dependent on the encoder type.

Table 12: Object 1008h

Object	Access	Data type	Designation	Data values
1008h	R	STRG 16 byte	Manufacturer Device Name	AFM60A-**E*18x12 AFS60A-**E*18x00

Object 1009h – Manufacturer Hardware Version

Table 13: Object 1009h

Object	Access	Data type	Designation	Datenwerte
1009h	R	STRG 8 byte	Manufacturer Hardware Version	E.g. HW_01.01 (depending on the release)

Object 100Ah – Manufacturer Software Version

Table 14: Object 100Ah

Object	Access	Data type	Designation	Data values
100Ah	R	STRG 8 byte	Manufacturer Software Version	E.g. UP1_1.03 (depending on the release)

Object 1010h – Save Parameter

Using this object the parameters are written to the EEPROM with the aid of the data value 65766173h = “save”.

CAUTION

Check whether the parameters have actually been written to the EEPROM!

The data are only written to the EEPROM in the ESM status Pre-Operational. The command is not executed in any other status, but it is also not identified as denied.

► Check whether the parameters have been saved using the object **2010h – Sensor Status S_STAT-C** (see table 78, page 55).

If the data are not saved in the EEPROM, the encoder loads the data last saved the next time the encoder is switched on. This situation can result in hazards for persons or damage to the system!

Table 15: Object 1010h

Object Subindex	Access	Data type	Designation Description	Data values
1010h	R/W	Record	Save Parameter	-
.0	R/W	UINT-8	Number of entries	1
.1	R/W	UINT-32	Total Class Parameters The parameters for all object types (1000h ..., 2000h ... and 6000h ...) are saved.	see table 16, page 33

Table 16: Object 1010h – details

Bit	Designation	Data values
31 ... 24	Byte 3	65h = e
23 ... 16	Byte 2	76h = v
15 ... 8	Byte 1	61h = a
7 ... 0	Byte 0	73h = s

Object 1011h – Load/Restore Parameter

Using this object the parameters are reset to the factory settings with the aid of the data value 64616F6Ch = “load”.

NOTE

- The data are only reset to the factory settings in the Pre-operational status. The command is not executed in any other status, but it is also not identified as denied.
- Then the data must be saved in the EEPROM using the object **1010h – Save Parameter**, otherwise the encoder will load the data saved in the EEPROM the next time it is switched on.

Table 17: Object 1011h

Object Subindex	Access	Data type	Designation Description	Data values
1011h	R/W	Record	Load/Restore Parameter	-
.0	R/W	UINT-8	Number of entries	1
.1		UINT-32	Total Class Parameters The parameters for all object types (1000h ..., 2000h ... and 6000h ...) are loaded.	see table 18, page 34

Table 18: Object 1011h – details

Bit	Designation	Data values
31 ... 24	Byte 3	64h = d
23 ... 16	Byte 2	61h = a
15 ... 8	Byte 1	6Fh = o
7 ... 0	Byte 0	6Ch = l

Object 1018h – Identity Object

Table 19: Object 1018h

Object Subindex	Access	Data type	Designation Description	Data values
1018h	R	Record	Identity Object	-
.0	R	UINT-8	Number of entries	4
.1	R	UINT-32	Vendor ID	01000056h = SICK
.2	R	UINT-32	Product Code	00007711h = AFS60 00007712h = AFM60
.3	R	UINT-32	Revision Number	00010001 = 1.01 (depending on the release)
.4	R	UINT-32	Serial Number JJWWxxxx (year/week/sequential number)	Serial number

Object 10F1h – Diagnosis Error Reaction

Table 20: Object 10F1h

Object Subindex	Access	Data type	Designation Description	Data values
10F1h	R/W	Record	Diagnosis Error Reaction	-
.0	R	UINT-8	Number of entries	2
.1	R	UINT-32	Defines error handling	0
.2	R	UINT-32	Sync Error Count Limit Limit of the counter for synchronization errors	0

Object 10F3h – Diagnosis History

Table 21: Object 10F3h

Object Subindex	Access	Data type	Designation Description	Data values
10F3h	R/W	Record	Diagnosis History	-
.0	R	UINT-8	Number of entries	25
.1	R	UINT-8	Maximum Messages Number of entries in subindex .6 ... .25	20
.2	R	UINT-8	Newest Message Subindex of the newest entry	6 ... 25
.3	R	UINT-8	Newest Acknowledged Message Subindex for the last entry acknowledged	6 ... 25

Object Subindex	Access	Data type	Designation Description	Data values
.4	R/W	BOOL	New Message Available Shows that a new entry is available	0 = No new entry 1 = New entry
.5	R	UINT-16	Flags Flags for the indication of the transmission and storage of errors	0
.6 ... .25	R/W	OCTETSTR	Diagnostics message, defined as octet character string	see "Error messages", page 78

3.6.4 PDO mapping objects

The PDO mapping objects are used to “map” other objects in the subindices and to transmit these to the controller or to receive them from the controller.

- Data are received cyclically from the PLC by the encoder using the Receive (Rx) PDO.
- Data are transmitted cyclically to the PLC by the encoder using the Transmit (Tx) PDO.

NOTE
Parameter changes to the PDO mapping objects are only executed in the ESM status Pre-Operational.

Object 1600h – 1st Receive (Rx) PDO mapping

NOTE
It is only possible to map the object **2000h – Control Word 1** to the object 1600h.

Table 22: Object 1600h

Object Subindex	Access	Data type	Designation Description	Data values
1600h	R/W	RECORD	1st Receive (Rx) PDO mapping	-
.0	R	UINT-8	Anzahl der Einträge	1
.1	R/W	UINT-32	Control Word 1 see table 67, page 50 auf Seite 55	20.00.00.10

Object 1A00h – 1st Transmit (Tx) PDO mapping

Table 23: Object 1A00h – default subindices

Object Subindex	Access	Data type	Designation
1A00h	R/W	RECORD	1st Transmit (Tx) PDO mapping
.0	R/W	UINT-8	Number of entries
.1	R/W	UINT-32	6004h Position Value
.2	R/W	UINT-32	6503h Alarm Status
.3	R/W	UINT-32	6505h Warning Status
.4	R/W	UINT-32	2010.01h STW-1 – Device Status Word, S_STAT-A
.5	R/W	UINT-32	2018.02h Time Stamp Sec

Object Subindex	Access	Data type	Designation
.6	R/W	UINT-32	2018.01h Time Stamp MSec
.7	R/W	UINT-32	2015h Temperature Value
.8	R/W	UINT-32	2019h Process Cycle Time
.9	R/W	UINT-32	6030h Speed Value 16-Bit

Object 1A01h – 2nd Transmit (Tx) PDO mapping

Table 24: Object 1A01h – default subindices

Object Subindex	Access	Data type	Designation
1A01h	R/W	RECORD	2nd Transmit (Tx) PDO mapping
.0	R/W	UINT-8	Number of entries
.1	R/W	UINT-32	10F3.04h Diagnosis History, Diagnosis Flag
.2	R/W	UINT-32	2017h Speed Value 32-Bit
.3	R/W	UINT-32	2016h Position Value, Raw
.4	R/W	UINT-32	2010.02h STW-1 – Device Status Word, S_STAT-B
.5	R/W	UINT-32	2010.03h STW-1 – Device Status Word, S_STAT-C
.6	R/W	UINT-32	6300.01h CAM State Register, Channel 1
.7	R/W	UINT-32	6300.02h CAM State Register, Channel 2
.8	R/W	UINT-32	2014h Time Stamp Counter
.9	-	-	-

Objects and subindices that can be mapped to the objects 1A00h and 1A01h

Table 25: Objects and subindices that can be mapped

Object Subindex	Length [Bit]	Designation	Data values	Details see
6004h	32	Position Value	60040020h	see table 36, page 42
6030h .1	16	Speed Value	60300110h	see table 37, page 42
6503h	16	Alarm Status	65030010h	see table 51, page 46
6505h	16	Warning Status	65050010h	see table 55, page 47
6300h .1 .2	8 8	CAM State Register Channel 1 Channel 2	63000108h 63000208h	see table 38, page 42
2010h .1 .2 .3	16 16 16	STW-1 – Device Status Word S_STAT-A S_STAT-B S_STAT-C	20100110h 20100210h 20100310h	see table 75, page 53
10F3h .4	8	Diagnosis History Diagnosis Flag	10F30408h	see table 21, page 34
2014h	32	Time Stamp Counter	20140020h	see table 82, page 58
2015h	16	Temperature Value	20150010h	see table 83, page 58

Object Subindex	Length [Bit]	Designation	Data values	Details see
2016h	32	Position Value, Raw	20160020h	see table 84, page 59
2017h	32	Speed Value 32-Bit	20170020h	see table 85, page 59
2018h .1 .2	16 16	Time Stamp Signals Time Stamp MSec Time Stamp Sec	20180110h 20180210h	see table 86, page 59
2019h	32	Process Cycle Time	20190020h	see table 87, page 59

Object 1C00h – Sync Manager (SM) Communication Type

The number of communication channels and the type of communication are defined using this object.

The entries are read-only. The communication channels are configured automatically on starting the EtherCAT master.

Table 26: Object 1C00h

Object Subindex	Access	Data type	Designation Description	Data values
1C00h	R	Array	Sync Manager (SM) Communication Type	-
.0	R	UINT-8	Number of entries	4
.1	R	UINT-8	Communication type sync manager 0 Communication type of Sync Manager 0	1: Receive mailbox (master to slave)
.2	R	UINT-8	Communication type sync manager 1 Communication type of Sync Manager 1	2: Send mailbox (slave to master)
.3	R	UINT-8	Communication type sync manager 2 Communication type of Sync Manager 2	3: Receive (Rx) PDO
.4	R	UINT-8	Communication type sync manager 3 Communication type of Sync Manager 3	4: Transmit (Tx) PDO

Object 1C12h – SM RxPDO assign

This object is used to allocate sync channel 2 to a PDO (channel 2 is reserved for Receive PDOs).

Table 27: Object 1C12h

Object Subindex	Access	Data type	Designation	Data values
1C12h	R	Record	SM RxPDO assign	-
.0	R	UINT-8	Number of entries	1

Object Subindex	Access	Data type	Designation	Data values
.1	R	UINT-16	PDO mapping object index of assigned RxPDO Index des RxPDOs	1600h

Object 1C13h – SM TxPDO assign

This object is used to allocate sync channel 3 to a PDO (channel 3 is reserved for Transmit PDOs).

Table 28: Object 1C13h

Object Subindex	Access	Data type	Designation Description	Data values
1C13h	R	Record	SM TxPDO assign	-
.0	R	UINT-8	Number of entries	2
.1	R	UINT-16	PDO mapping object index of assigned TxPDO 1 Index of the 1. TxPDO	1A00h
.2	R	UINT-16	PDO mapping object index of assigned TxPDO 2 Index of the 2. TxPDO	1A01h

Objects 1C32h and 1C33h – SM-2/-3 Output Parameter

Table 29: Objects 1C32h and 1C33h

Object Subindex	Access	Data type	Designation Description	Data values
1C32h/ 1C33h	R	Record	SM-2/-3 Output Parameter	-
.0	R	UINT-8	Number of entries	32
.1	R/W	UINT-16	Sync Mode **00h** Free Run (no synchronization) **01h** Synchronous with SM-3 event **22h** Synchronous with SM-2 event **02h** DC mode, synchronous with Sync0 event	-
.2	R oder R/W	UINT-32	Cycle time Dependent of the sync mode Value in ns	-
.3	R	UINT-32	Shift Time	-
.4	R	UINT-16	Sync modes supported Supported synchronization types Bit 0: Free Run Bit 1: Sync SM event Bit 4 ... 2: Sync mode[1)] Bit 6 ... 5: Shift mode[2)] Bit 15 ... 7:Reserved	-
.5	R	UINT-32	Minimum Cycle Time Minimum cycle time (in ns)	-

Object Subindex	Access	Data type	Designation Description	Data values
.6	R	UINT-32	Calc and Copy Time Time between reading the inputs and the availability of the inputs for the master (in ns, DC mode only)	-
.7		-	-	-
.8	R/W	UINT-16	Get Cycle Time	-
.9	R	UINT-32	Delay Time Time between Sync1 event and reading the inputs (in ns, DC mode only)	-
.10	R	UINT-32	Sync0 Cycle Time	-
.11	R	UINT-16	Cycle Time Too Small Number of cycle time infringements in the Operational status (cycle was not completed on time or the next cycle came too early)	-
.12	R	UINT-16	SM Event Missed Number of failed SM events in the Operational status (DC mode only)	-
.13	R	UINT-16	Shift Time Too Short Number of excessively short spaces between Sync0 and Sync1 events (DC mode only)	-
.14	R	UINT-16	RxPDO Toggle Failed	-
.15 ... .31		-	Reserved	-
.32	R	-	Sync Error	-

1 For Bit 4 ... 2 only the value 001 = Sync0 event is supported.
2 For Bit 6 ... 5 only the value 00 = no shift is supported.

3.6.5 Overview of the encoder profile-specific objects

Table 30: Implemented encoder profile specific objects

Object Subindex	Access	Data type	Designation
6000h	R/W	UINT-16	Operating Parameter
6001h	R/W	UINT-32	Counts Per Revolution (CPR)
6002h	R/W	UINT-32	Counts per Measuring Range (CMR)
6003h	R/W	UINT-32	Preset Value
6004h	R	UINT-32	Position Value
6030h .0 1	R	Array of UINT-16	Velocity/Speed Value
6300h .0 2	R	Array of UINT-8	CAM State Register
6301h .0 2	R/W	Array of UINT-8	CAM Enable Register
6302h .0 2	R/W	Array of UINT-8	CAM Polarity Register

Object Subindex	Access	Data type	Designation
6310h ... 6317h .0 2	R/W	Array of UINT-32	CAM-1 ... 8 – Lower Limit setting
6320h ... 6327h .0 2	R/W	Array of UINT-32	CAM-1 ... 8 – Upper Limit setting
6330h ... 6337h .0 2	R/W	Array of UINT-16	CAM-1 ... 8 – Hysteresis setting
6500h	R	UINT-16	Operating Status
6501h	R	UINT-32	Physical Resolution Span (PRS) Single Turn Resolution
6502h	R	UINT-16	Number of Revolutions
6503h	R	UINT-16	Alarms
6504h	R	UINT-16	Supported Alarms
6505h	R	UINT-16	Warnings
6506h	R	UINT-16	Supported Warnings
6507h	R	UINT-32	Version Of Profile & Software
6508h	R	UINT-32	Operating Time
6509h	R	INT-32	Offset Value
650Ah .0 3	R	Array of UINT-32	Module Identification
650Bh	R	UINT-32	Serial Number

3.6.6 Detailed information on the encoder parameters

Object 6000h – Operating parameters

Table 31: Object 6000h

Object	Access	Data type	Designation	Data values
6000h	R/W	UINT-16	Operating parameters	see table 32, page 40

Table 32: Object 6000h – Details

Bit	Designation Description	Data values
15	Fast Data Exchange Mode	**0** No **1** Yes
14 ... 13	Reserved	-
12	Activation of object 2022h Absolute Diagnosis Service Parameter To activate object 2022h, the following steps must be carried out: 1. Object 6000h Set bit 12 to 1 2. Execute the "Save Parameter" operation (object 1010h) 3. Performing a reset or restart Object 2022h then becomes visible in the object library.	**0** No **1** Yes
11 ... 3	Reserved	-

Bit	Designation Description	Data values
2	Scaling The bit enables scaling with objects 6001h and 6002h.	**0** Not active **1** Active
1	Commissioning Diagnostic Control is not supported	-
0	Code sequence (cw, ccw) The code sequence determines at which direction of rotation, starting from a viewing direction on the shaft, the position value increases. • Clockwise = Increasing position value when shaft is rotated clockwise • Counterclockwise = Increasing position value when shaft is rotated counterclockwise	**0** cw **1** ccw

Object 6001h – Counts Per Revolution (CPR)

This parameter is used to configure the resolution per revolution.

NOTE

The parameter is not used if the round axis functionality is activated.

Table 33: Object 6001h

Object	Access	Data type	Designation Description	Data values (default value)
6001h	R	UINT-32	Counts Per Revolution (CPR) Number of increments per revolution	00000001h 00040000h (00040000h)

Object 6002h – Total Measuring Range (CMR)

Table 34: Object 6002h

Object	Access	Data type	Designation Description	Data values
6002h	R	UINT-32	Total Measuring Range (CMR) Total resolution	Depends on type

Object 6003h – Preset Value

This parameter is used to set the position value of the encoder to a preset value. This allows, for example, the zero position of the encoder to be aligned with the machine zero point.

Table 35: Object 6003h

Object	Access	Data type	Designation Description	Data values
6003h	R/W	UINT-32	Preset value Preset value	-

NOTE

- When the value is written to the object, it is immediately adopted as the new position value.
- The preset value must be within the configured measuring range.

Object 6004h – Position Value

This object can be used to read out the current position value.

Table 36: Object 6004h

Object	Access	Data type	Designation Description	Data values
6004h	R	UINT-32	Position Value Current position value	-

NOTE
Instead of the position value, an error code (Err_PosVal) can also be output (see table 76, page 53). The output of the Err_PosVal must be configured with object 6000h (see table 31, page 40).

Object 6030h – Speed Value

This object can be used to read out the current speed.

Table 37: Object 6030h

Object	Access	Data type	Designation Description	Data values
6030h	R	Array INT-16	Speed Value	-
.0	R	INT-16	Number of entries	1
.1	R	INT-16	Speed Value Speed in 16 bit	–32,768 +32,767

3.6.7 Detailed information on the electronic cam mechanism (CAM)

A so-called electronic cam mechanism can be configured using the encoder. One CAM channel with up to eight cam switching positions is supported. Each position parameter is defined by its minimum switching point (objects 6310h to 6317h), its maximum switching point (objects 6320h to 6327h) and its switching hysteresis (objects 6330h to 6337h).

Object 6300h – CAM State Register

The cam switching states are output using the object 6300h.

Table 38: Object 6300h

Object Subindex	Access	Data type	Designation	Data values
6300h	R	Array UINT-8	CAM State Register	-
.0	R	UINT-8	Number of entries	2
.1	R	UINT-8	Channel 1	00h FFh
.2	R	UINT-8	Channel 2	00h FFh

Table 39: Object 6300h – details

Bit	Designation	Data values
7	Cam 8	**0** Not active **1** Active
6	Cam 7	**0** Not active **1** Active
5	Cam 6	**0** Not active **1** Active

Bit	Designation	Data values
4	Cam 5	**0** Not active **1** Active
3	Cam 4	**0** Not active **1** Active
2	Cam 3	**0** Not active **1** Active
1	Cam 2	**0** Not active **1** Active
0	Cam 1	**0** Not active **1** Active

If, for instance, the value read is 01h (00000001b), then cam 1 is active. None of the other cams are active. If, for instance, the value read is 88h (10001000b), then cams 8 and 4 are active. None of the other cams are active.

Object 6301h – CAM Enable Register

Each cam switching position on the CAM channel must be enabled individually in the encoder. The individual cams are enabled by writing the appropriate value to the object 6301h, subindex .1 or subindex .2.

Every cam switching position that is to be used must be set to 1 in binary notation.

Table 40: Object 6301h

Object Subindex	Access	Data type	Designation	Data values
6301h	R/W	Array UINT-8	CAM Enable Register	-
.0	R	UINT-8	Number of entries	2
.1	R/W	UINT-8	Channel 1	00h FFh
.2	R/W	UINT-8	Channel 2	00h FFh

Table 41: Object 6301h – details

Bit	Designation	Data values
7	Cam 8	**0** Not used **1** Used
6	Cam 7	**0** Not used **1** Used
5	Cam 6	**0** Not used **1** Used
4	Cam 5	**0** Not used **1** Used
3	Cam 4	**0** Not used **1** Used
2	Cam 3	**0** Not used **1** Used
1	Cam 2	**0** Not used **1** Used
0	Cam 1	**0** Not used **1** Used

If, for instance 4Ah (01001010b) is transmitted in the subindex, the cams 2, 4 and 7 are used. All other cams are not used.

Object 6302h – CAM Polarity Register

Using the CAM Polarity Register it can be defined whether the cams are output as active high or active low. By default the cams are defined as active high. They therefore output 1 when the cam switching position is reached.

Table 42: Object 6302h

Object Subindex	Access	Data type	Designation	Data values
6302h	R/W	Array UINT-8	CAM Polarity Register	-
.0	R	UINT-8	Number of entries	2
.1	R/W	UINT-8	Channel 1	00h FFh
.2	R/W	UINT-8	Channel 2	00h FFh

Table 43: Object 6301h – details

Bit	Designation	Data values
7	Cam 8	**0** High active **1** Low active
6	Cam 7	**0** High active **1** Low active
5	Cam 6	**0** High active **1** Low active
4	Cam 5	**0** High active **1** Low active
3	Cam 4	**0** High active **1** Low active
2	Cam 3	**0** High active **1** Low active
1	Cam 2	**0** High active **1** Low active
0	Cam 1	**0** High active **1** Low active

Objects 6310h ... 6317h – CAM-1 ... 8, Lower Limit

The lower switching point of a cam switching position is defined using the Lower Limit. Each individual cam switching position (CAM 1 to CAM 8) has its own Lower Limit object (6310h = cam 1 ... 6317h = cam 8).

NOTE

- The Lower Limit can only be configured, i.e., its value changed, if the Upper Limit for the same CAM has already been set (see table 45, page 45).
- The value for the Lower Limit must be lower than the value for the Upper Limit.

Table 44: Object 6310h ... 6317h

Object Subindex	Access	Data type	Designation	Data values (default value)
6310h ... 6317h	R/W	Array UINT-32	CAM-1 ... 8, Lower Limit	-
.0	R	UINT-32	Number of entries	2
.1	R/W	UINT-32	Channel 1	0 ... PMR[1)] – 1 (0)

Object Subindex	Access	Data type	Designation	Data values (default value)
.2	R/W	UINT-32	Channel 2	0 ... PMR[1)] – 1 (0)

1 Physical measuring range, depending on the encoder type.

Objects 6320h ... 6327h – CAM-1 ... 8, Upper Limit

The upper switching point for a cam switching position is defined using the Upper Limit. Each individual cam switching position (CAM 1 to CAM 8) has its own Upper Limit object (6320h = cam 1 ... 6327h = cam 8).

Table 45: Object 6320h ... 6327h

Object Subindex	Access	Data type	Designation	Data values (default value)
6320h ... 6327h	R/W	Array UINT-32	CAM-1 ... 8, Upper Limit	-
.0	R	UINT-32	Number of entries	2
.1	R/W	UINT-32	Channel 1	0 ... PMR[1)] – 1 (PMR – 1)
.2	R/W	UINT-32	Channel 2	0 ... PMR[1)] – 1 (PMR – 1)

1 Physical measuring range, depending on the encoder type.

Objects 6330h ... 6337h – CAM-1 ... 8, Hysteresis

The width of the hysteresis of the switching points can be defined using the CAM hysteresis. For each individual cam switching position (CAM 1 to CAM 8) a dedicated CAM hysteresis can be set (6330h = cam 1 ... 6337h = cam 8).

Table 46: Object 6330h ... 6337h

Object Subindex	Access	Data type	Designation	Data values
6330h ... 6337h	R/W	Array UINT-16	CAM-1 ... 8, Hysteresis	-
.0	R	UINT-16	Number of entries	2
.1	R/W	UINT-16	Channel 1	0000h FFFFh
.2	R/W	UINT-16	Channel 2	0000h FFFFh

3.6.8 Detailed information on the diagnostics

Object 6500h – Operating Status

Table 47: Object 6500h

Object	Access	Data type	Designation	Data values
6500h	R	UINT-16	Operating Status	see table 48, page 45

Table 48: Object 6500h – details

Bit	Designation	Data values
15 ... 13	Reserved	-
12	Support additional error code	**0** No **1** Yes
11 ... 3	Reserved	-

Bit	Designation	Data values
2	Scaling	**0** Not active **1** Active
1	Commissioning diagnostic control	**0** Not active **1** Active
0	Code sequence (cw, ccw)	**0** cw **1** ccw

Object 6501h – PRS, Single Turn Resolution

Table 49: Object 6501h

Object	Access	Data type	Designation Description	Data values
6501h	R	UINT-32	PRS, Single Turn Resolution Singleturn resolution	00040000h

Object 6502h – Number of Revolutions

Table 50: Object 6502h

Object	Access	Data type	Designation Description	Data values
6502h	R	UINT-16	Number of Revolutions Multiturn resolution	AFS = 0001h AFM = 4.096

Object 6503h – Alarm Status

Table 51: Object 6503h

Object	Access	Data type	Designation Description	Data values
6503h	R	UINT-16	Alarm Status Alarms in case of encoder errors that could result in an incorrect position value	0000h FFFFh

Table 52: Object 6503h – details

Bit	Bezeichnung	Datenwerte
15 ... 13	Reserved	-
12	EEPROM error Dependent of Bit 15 and 7 of object 2010h .1 (see table 76, page 53	**0** Not active **1** Active
11 ... 1	Reserved	-
0	Position error Dependent of Bit 14, 12 ... 6 and 4 of object 2010h .1 (see table 76, page 53)	**0** Not active **1** Active

Object 6504h – Supported Alarms

Table 53: Object 6504h

Object	Access	Data type	Designation Description	Data values
6504h	R	UINT-16	Supported Alarms Alarms implemented in the encoder	1001h

Table 54: Object 6504h – details

Bit	Bezeichnung	Data values
15 ... 13	Manufacturer-specific	**0** Not supported
12	EEPROM error	**1** Supported
11 ... 2	Reserved	-
1	Commissioning diagnostics	**0** Not supported
0	2 Position error	**1** Supported

Object 6505h – Warning Status

Table 55: Object 6505h

Object	Access	Data type	Designation Description	Data values
6505h	R	UINT-16	Warning Status Warnings on deviation from operating parameters	0000h FFFFh

Table 56: Object 6505h – details

Bit	Description	Data values
15	Supply voltage outside the permissible range	**0** Not active **1** Active
14	Reserved	-
13	Operating temperature outside the permissible range	**0** Not active **1** active
12	Frequency/rotational speed outside the range allowed	**0** Not active **1** active
11 ... 2	Reserved	-
1	Sensor LED current too high	**0** Not active **1** Active
0	Maximum frequency/rotational speed outside the range allowed	**0** Not active **1** active

Object 6506h – Supported Warnings

Table 57: Object 6506h

Object	Access	Data type	Designation Description	Data values
6506h	R	UINT-16	Supported Warnings Warnings implemented in the encoder	B003h

Table 58: Object 6506h – details

Bit	Description	Data values
15	Supply voltage outside the permissible range	**1** Supported
14	Reserved	-
13	Operating temperature outside the permissible range	**1** Supported
12	Frequency outside the permissible range	**1** Supported
11 ... 6	Reserved	-
5	Reference point not reached	**0** Not supported
4	Battery voltage too low	**0** Not supported

Bit	Description	Data values
3	Max. operating time exceeded	**0** Not supported
2	CPU watchdog status	**0** Not supported
1	Minimum internal LED current in the sensors reached	**1** Supported
0	Maximum frequency exceeded	**1** Supported

Object 6507h – Version Of Profile & Software

Table 59: Object 6507h

Objekt	Access	Data type	Designation Description	Data values
6507h	R	UINT-32	Version Of Profile & Software The first two bytes contain the software version, the next two the profile version..[1)]	00000000h FFFFFFFFh

1 Internal manufacturer software version, can vary from the objects 100Ah and 1018h.

Table 60: Object 6507h – details

Bit	Description	Example values	Example
31 ... 24	First part of the software version	03h	3.1
23 ... 16	Last part of the software version	01h	
15 ... 8	First part of the profile version	01h	1.40
7 ... 0	Last part of the profile version	40h	

Object 6508h – Operating Time

Table 61: Object 6508h

Object	Access	Data type	Designation Description	Data values
6508h	R	UINT-32	Operating Time Operating time in units of 0.1 h	00000000h FFFFFFFFh

Object 6509h – Internal Offset Value

Table 62: Object 6509h

Object	Access	Data type	Designation Description	Data values
6509h	R	UINT-32	Internal Offset Value Offset value, calculated from the Preset function 6003h (see "Preset function", page 11)	00000000h FFFFFFFFh

Object 650Ah – Module Identification

Table 63: Object 650Ah

Object Subindex	Access	Data type	Designation Description	Data values (default value)
650Ah	R	Array	Module Identification	
.0	R	UINT-32	Number of entries	3

Object Subindex	Access	Data type	Designation Description	Data values (default value)
.1	R	UINT-32	Manufacturer Offset Value Manufacturer-specific off-set	(0)
.2	R	UINT-32	Position Value Minimum Lowest position value	0
.3	R	UINT-32	Position Value Maximum Highest position value	PMR[1)] – 1

1 Physical measuring range, depending on the encoder type.

Object 650Bh – Serial Number

Table 64: Object 650Bh

Object Subindex	Access	Data type	Designation Description	Data values
650Bh	R	UINT-32	Serial Number YYWWxxxx (year/week/sequential number)	Serial number

3.6.9 Overview of the manufacturer-specific objects

In the manufacturer-specific objects a differentiation is made between the following object types:

- objects for the encoder configuration
- objects that provide status information

Table 65: Implemented manufacturer-specific objects for the encoder configuration

Object Subindex	Access	Data type	Designation
2000h	R/W	UINT-16	Control Word 1
2001h .0 3	R/W	Array UINT-32	Endless-Shaft Configuration
2002h .0 6	R/W	Array UINT-16	Speed Calculation Configuration
2004h	R/W	UINT-32	Configuration Install Service
2005h	R/W	UINT-32	Configuration Preset Value
2006h .0 4	R/W	Record	Physical Measuring Range Limits

Table 66: Implemented manufacturer-specific objects that provide status information

Object Subindex	Access	Data type	Designation
2010h .0 3	R	Array UINT-16	Sensor Status (STW-1)
2011h .0 8	R	Array UINT-32	Real Scaling Parameter Settings
2012h .0 ... .15	R	Record	Relative Diagnosis Service Parameters
2013h .0 ... .15	R	Record	Diagnosis Error Logging Parameter
2014h	R	UINT-32	Time Stamp
2015h	R	UINT-16	Temperature Value

Object Subindex	Access	Data type	Designation
2016h	R	UINT-32	Position Value Raw
2017h	R	INT-32	Speed Value 32-Bit
2018h .0 2	R	Array UINT-16	Time Stamp Signals
2019h	R	UINT-32	Process Cycle Time
2022h .0 ... .15	R	Record	Absolute Diagnosis Service Parameters

3.6.10 Detailed information on objects for encoder configuration

Object 2000h – Control Word 1

The object sets the encoder to a preset value if necessary.

Table 67: Object 2000h

Object	Access	Data type	Designation	Data values
2000h	R/W	UINT-16	Control Word 1	see table 68, page 50

Table 68: Object 2000h – Details

Bit	Designation Description	Data values
15 ... 13	Reserved	-
12	Preset Function Request (PreReq) Sets the preset value that is transferred with the 2005h object (see table 73, page 52).	**0** Deactivated **1** Active
11	Preset Mode = Shift Positive The preset value is added to the current position value.	**0** Deactivated **1** Active
10	Preset Mode = Shift Negative The preset value is subtracted from the current position value.	**0** Deactivated **1** Active
9 ... 1	Reserved	-
0	Preset Mode = Preset Zero Sets the position value to 0	**0** Deactivated **1** Active

NOTE

- If no preset mode is specified with bit 11, 10 or 0, the preset value from object 2005h is adopted as the position value.
- Bits 11, 10 and 0 must be used exclusively. If several of these three bits have the value 1, the preset function is not executed.
- The preset function is triggered with the rising edge (transition bit 12 from 0 to 1). To set a preset value again, the bit must first be reset to 0.

Object 2001h – Endless-Shaft Configuration

Table 69: Object 2001h

Object Subindex	Access	Data type	Designation Description	Data values (default value)
2001h	R/W	Array UINT-16	Endless-Shaft Configuration	-
.0	R/W	UINT-16	Number of entries	3

Object Subindex	Access	Data type	Designation Description	Data values (default value)
.1	R/W	UINT-16	Control of Endless-Shaft Mode Activates the round axis functionality	**2** Active **1** Not active
.2	R/W	UINT-16	Number of revolutions, nominator Counter for the number of revolutions (CNR_N)	1 ... 2,048 (2,048)
.3	R/W	UINT-16	Number of revolutions, divisor Denominator for the number of revolutions (CNR_D).	1 ... 2,048 (1)

NOTE
The round axis functionality can only be used with the multiturn encoder. It is only executed if scaling has been switched on with object 6000h.

Object 2002h – Speed Calculation Configuration

Table 70: Object 2002h

Object Subindex	Access	Data type	Designation Description	Data values (default value)
2002h	R/W	Array UINT-16	Speed Calculation Configuration	-
.0	R/W	UINT-16	Number of entries	6
.1	R/W	UINT-16	Operation Control Controls the speed calculation mode	**0** Not active **1** Active
.2	R/W	UINT-16	Format Measuring Units Speed measurement unit	**0** cps **1** cp100ms **2** cp10ms **3** rpm **4** rps
.3	R/W	UINT-16	T1 Update Time in MS Update time in ms	AFS60 = 2 AFM60 = 1 ... 50 (2)
.4	R/W	UINT-16	T2 Integration Time Integration time dependent on T1	1 ... 200 (200)
.5	R/W	UINT-16	Upper Limit Warning in rpm Maximum speed, a warning is issued if this is exceeded	1 ... 10,000 (6,000)
.6	R/W	UINT-16	Lower Limit Warning in rpm Minimum speed, a warning is issued if this is not reached	0 ... 9,000 (0)

The speed is calculated from the average of several measurements. The integration time T2 specifies the number of values from which the average is calculated. The update time T1 indicates the time interval between the individual measurements.

Example:

If T1 = 2 ms and T2 = 200, then the speed is calculated from the last 0.4 s.

Object 2004h – Configuration Install Service

Table 71: Object 2004h

Object Subindex	Access	Data type	Designation	Data values
2004h	R/W	UINT-32	Configuration Install Service	see table 72, page 52

Table 72: Object 2004h – Service codes

Data values	Description
70100100h	Reset-0, simulates switching the encoder on/off (power on). Parameters are not saved
70100101h	Reset-1, simulates switching the encoder on/off (power on). Parameters (offset, preset value and offset for rotary axis) are saved
71001021h	Resets the relative diagnostic data in object 2012h
78001001h	Reactivates the synchronization mode in Operational Mode (Synchronous to SM-2/-3 event or DC Sync Mode)
78001009h	Stops the synchronization mode in Operational Mode (Synchronous to SM-2/-3 event or DC Sync Mode)

Object 2005h – Configuration Preset Value

This parameter is used to transfer a preset value to the encoder. This preset value must be set with object 2000h (see table 67, page 50) must be set.

Table 73: Object 2005h

Object Subindex	Access	Data type	Designation	Data values
2005h	R/W	UINT-32	Configuration Preset Value	0 ... CMR-1

NOTE
The preset value must be within the configured measuring range.

Object 2006h – Physical Measuring Range Limits

Table 74: Object 2006h

Object Subindex	Access	Data type	Designation Description	Data values (default value)
2006h	R/W	Record	Physical Measuring Range Limits	-
.0	R	UINT-8	Number of entries	4
.1	R/W	SINT-16	Temperature Lower Limit Defines the lower limit of the permitted operating temperature in °C	–40 +80 (-40)
.2	R/W	SINT-16	Temperature Upper Limit Defines the upper limit of the permitted operating temperature in °C	–20 +120 (+100)
.3	R/W	UINT-16	Operating Voltage Lower Limit Defines the lower limit of the permitted supply voltage in mV	9000 24000 (10,000)

Object Subindex	Access	Data type	Designation Description	Data values (default value)
.4	R/W	UINT-16	Operating Voltage Upper Limit Defines the upper limit of the permitted supply voltage in mV	10,000 30,000 (30,000)

3.6.11 Detailed information on objects that provide status information

Object 2010h – STW-1 – Device Status Word

Table 75: Object 2010h

Object Subindex	Access	Data type	Designation	Data values
2010h	R	Array UINT-16	STW-1 – Device Status Word	-
.0	R	UINT-16	Number of entries	3
.1	R	UINT-16	S_STAT-A, Sensor State	0000h ... FFFFh
.2	R	UINT-16	S_STAT-B, State Flag 2	0000h ... FFFFh
.3	R	UINT-16	S_STAT-C, State Flag 3	0000h ... FFFFh

Table 76: Object 2010h - Sensor status (S_STAT-A)

Bit	Description	Position value (Err_PosVal)
15	Memory error (Memory): Invalid EEPROM checksum during initialization	-12
14	Position error: Invalid communication to the I²C device[1)] in the sensor module	-11
13	Reserved	-
12	Position error: Invalid EEPROM checksum or Invalid internal SSI communication (MFP4 signal[2)])	-9
11	Position error: Invalid or no synchronization of MA sensor[3)] to LY singleturn position[4)]	-8
10	Position error: The error register in LY is activated (MFP5 signal[2)]). or Invalid internal SSI communication (MFP4 signal[2)])	-7
9	Position error: Error in the calculation of the vector length Sin^2 + Cos^2 of the multiturn stage	-6
8	Position error: Error in the calculation of the vector length Sin^2 + Cos^2 of the singleturn stage	-5
7	Position and memory errors: Invalid communication to the I²C device in the main module	-4
6	Position error: Error in the calculation of the amplitude values Sin + Cos of the singleturn stage	-3

Bit	Description	Position value (Err_PosVal)
5	Warning regarding speed: Current measured value outside the minimum or maximum limit value	-
4	Position error: Error in the calculation of the amplitude values, Sin + Cos of the multiturn stage	-2
3	Warning regarding the supply voltage: Current measured value outside the minimum or maximum limit value	-
2	Warning, sensor LED current critical: Current measured value outside the minimum or maximum limit value	-
1	Warning regarding the temperature: Current measured value outside the minimum or maximum limit value	-
0	Warning: General start-up error when switching on	-

1 Internal interface between EEPROM and sensor of the encoder.

2 Output signal from the sensor of the encoder.

3 Internal hall sensor that determines the multiturn position by means of magnetic sensing.

4 LY = internal sensor for the singleturn position.

NOTE

- If several errors occur, the position value -16 is output.
- The Err_PosVal is output instead of the position value and enables an error to be detected using the cyclical process data (see table 36, page 42).
- The output of the Err_PosVal must be configured with object 6000h (see table 31, page 40).

Table 77: Object 2010h – Sensor status (S_STAT-B)

Bit	Description
15	Memory error due to an invalid checksum when reading the EEPROM during encoder initialization: • In the sensor configuration data area
14	• In the device configuration data area
13	• In the basic process data diagnostics area
12	• In the service data diagnostics area
11	• In the area of user configuration, communication mapping
10	Reserved
9	• In the user configuration area, parameters of the electronic cam controller (CAM)
8	• In the user configuration area, basic parameters
7	Reserved
6	Process data cycle times under 480 µs
5	Warning, speed above the configured maximum value
4	Warning, occurred when executing the preset function. The preset value is outside the measuring range (CMR).

Bit	Description
3	Warning, occurred when changing or writing parameters: • In the area of manufacturer-specific objects
2	• In the area of objects for the electronic camshaft
1	• In the area of encoder profile-specific objects
0	• In the PDO configuration area

Table 78: Object 2010h – Sensor status (S_STAT-C)

Bit	Description
15	Information: Encoder in synchronous mode. Position formation **is synchronized** with the process data cycle of the master
14	Information: Encoder in Free Run mode. Position formation **is not synchronized** with the process data cycle of the master
13	Reserved
12	Preset function was triggered by object 2000h (see table 67, page 50) and confirmed
11 ... 4	Reserved
3 2	Status information about saving internal diagnostic values: Bit 3 = 1 and bit 2 = 0: Memory operation completed Bit 3 = 0 and bit 2 = 1: Memory operation requested and process running
1 0	Saving the configuration data with the Save command (object 1010h, see table 15, page 33): Bit 1 = 1 and bit 0 = 0: Memory operation completed Bit 1 = 0 and bit 0 = 1: Memory operation requested and process running

Object 2011h – Real Scaling Parameter Settings

Table 79: Object 2011h

Object Subindex	Access	Data type	Designation Description	Data values
2011h	R	Array UINT-32	Real Scaling Parameter Settings	-
.0	R	UINT-32	Number of entries	8
.1	R	UINT-32	Endless-Shaft Operation Mode	**1** Not active **2** Active
.2	R	UINT-32	Endless-Shaft Offset Offset of the endless shaft function	00000000h 40000000h
.3	R	UINT-32	Internal PMR Shift Value Internal PMR shift value	
.4	R	UINT-32	CNR_N, Number of Revolutions, Nominator Numerator for the number of revolutions	1 ... 2,048
.5	R	UINT-32	CNR_D, Number of Revolutions, Divisor Denominator for the number of revolutions	1 ... 2,048
.6	R	UINT-32	CMR, Counts per Measuring Range Total resolution	1 ... 40000000h

Object Subindex	Access	Data type	Designation Description	Data values
.7	R	UINT-32	CPR, Counts Per Revolution (Integer) Number per revolution, number before the decimal point	Example: at 1.555 = 1
.8	R	UINT-32	CPR, Counts Per Revolution (Fract) Number per revolution, number after the decimal point	Example: at 1.555 = 555

Object 2012h – Relative Diagnosis Service Parameter

This diagnostic data can be reset via service code 71001021h in object 2004h.

Table 80: Object 2012h

Object Subindex	Access	Data type	Designation Description	Data values
2012h	R	Array UINT-32	Diagnosis Service Parameter	-
.0	R	UINT-32	Number of entries	15
.1	R	UINT-32	Number of Switch-On Power-on counter	-
.2	R	UINT-32	Operating Time Moving Operating time in s, the time in which the encoder has moved is output[1)]	-
.3	R	UINT-32	Max. Operating Speed Maximum speed in rpm since the encoder has been in operation	-
.4	R	UINT-32	Starts with Direction Forward Counter for movements of the encoder in forward rotation[1)]	-
.5	R	UINT-32	Starts with Direction Backward counter for starting the encoder in backward rotation[1)]	-
.6	R	UINT-32	Starts with Alternating Directions Counter for starting the encoder in alternating rotation[1)]	-
.7	R	UINT-32	Operating Hours Counter Operating hours counter (× 0.1 h)	-
.8	R	UINT-16	Min. Operating Temperature Minimum operating temperature in °C	-

Object Subindex	Access	Data type	Designation Description	Data values
.9	R	UINT-16	Max. Operating Temperature Maximum operating temperature in °C	-
.10	R	UINT-16	Min. Operating LED Current Minimum internal LED current in µA	-
.11	R	UINT-16	Max. Operating LED Current Maximum internal LED current in µA	-
.12	R	UINT-16	Min. Operating Voltage Minimum supply voltage in mV	-
.13	R	UINT-16	Max. Operating Voltage Maximum supply voltage in mV	-
.14	R	UINT-32	Internal FPGA Revision Number FPGA revision number	-
.15	R	UINT-32	Counter of Diagnosis Storage Counter for the storage processes in the EEPROM	-

1 From movements with a speed > 12 rpm.

Object 2013h – Diagnosis Error Logging Parameter

Table 81: Object 2013h

Object Subindex	Access	Data type	Designation Description	Data values
2013h	R	Record	Diagnosis Error Logging Parameter	-
.0	R	UINT-8	Number of entries	16
.1	R	UINT-32	Temperature out of range Operating temperature outside the configured minimum or maximum limit value	-
.2	R	UINT-32	LED current out of range Sensor LED current outside the configured minimum or maximum limit value	-
.3	R	UINT-32	Voltage out of range Supply voltage outside the configured minimum or maximum limit value	-
.4	R	UINT-32	Amplitude multi Error in the calculation of the amplitude values Sin + Cos of the multiturn stage	-

Object Subindex	Access	Data type	Designation Description	Data values
.5	R	UINT-32	Frequency out of range Speed outside the configured minimum or maximum limit value	-
.6	R	UINT-32	Amplitude single Error in the calculation of the amplitude values Sin + Cos of the singleturn stage	-
.7	R	UINT-32	Communication EEPROM - I²C Invalid communication to the I2C device	-
.8	R	UINT-16	Vector length single Error in the calculation of the vector length Sin^2 + Cos^2 of the singleturn stage	-
.9	R	UINT-16	Vector length multi Error in the calculation of the vector length Sin^2 + Cos^2 of the multiturn stage	-
.10	R	UINT-16	Singleturn position Calculation of the singleturn position incorrect	-
.11	R	UINT-16	Invalid or no synchronization from MA Sensor to LY singleturn position	-
.12	R	UINT-16	Invalid internal SSI communication (MFP4 signal)	-
.13	R	UINT-16	Synchronization error multiturn/singleturn stage	-
.14	R	UINT-32	Invalid communication to the I²C device in the sensor module	-
.15	R	UINT-32	Invalid EEPROM checksum during initialization	-

Object 2014h – Time Stamp Counter

Table 82: Object 2014h

Object Subindex	Access	Data type	Designation Description	Data values
2014h	R	UINT-32	Time Stamp Counter Time stamp in ms, total range 4,290,200 seconds or 136 years	00000000h FFB741C0h

Object 2015h – Temperature Value

Table 83: Object 2015h

Object Subindex	Access	Data type	Designation Description	Data values
2015h	R	UINT-32	Temperature value Operating temperature in °C	-

Object 2016h – Position Value, Raw

Table 84: Object 2016h

Object Subindex	Access	Data type	Designation Description	Data values
2016h	R	UINT-32	Position Value, Raw Position value independent of any preset value	AFS60 = 0 ... 0003FFFFh AFM60 = 0 ... 3FFFFFFFh

Object 2017h – Speed Value 32-Bit

Table 85: Object 2017h

Object Subindex	Access	Data type	Designation Description	Data values
2017h	R	UINT-32	Speed Value 32 Bit Speed value in 32 bit	-

Object 2018h – Time Stamp Signals

Table 86: Object 2018h

Object Subindex	Access	Data type	Designation Description	Data values
2018h	R	Array UINT-16	Time Stamp Signals	
.0	R	UINT-16	Number of entries	2
.1	R	UINT-16	Time Stamp MSec Time stamp in milliseconds	0000h FFFFh
.2	R	UINT-16	Time Stamp Sec Time stamp in seconds	0000h FFFFh

Object 2019h – Process Cycle Time

This object is used to output either the internal or the external cycle time. The internal cycle time is determined by the encoder in Free Run mode and is always 500 µs. The external cycle time is determined by the master in **Synchronous to SM- 2/-3 event** or **DC Sync** mode and is between 125 µs and 100,000 µs.

Table 87: Object 2019h

Object Subindex	Access	Data type	Designation Description	Data values
2019h	R	UINT-32	Process Cycle Time Cycle time in µs	125 100,000

Object 2022h – Absolute Diagnosis Service Parameter

To activate object 2022h, the following steps must be carried out:

1. Object 6000h Set bit 12 to 1
2. Execute the "Save Parameter" operation (object 1010h)
3. Performing a reset or restart

Object 2022h then becomes visible in the object library .

The diagnostic data contained in object 2022h is recorded from the production of the encoder and cannot be reset.

Table 88: Object 2022h

Object Subindex	Access	Data type	Designation Description	Data values
2022h	R	Array UINT-32	Diagnosis Service Parameter	-
.0	R	UINT-32	Number of entries	15
.1	R	UINT-32	Number of Switch-On Power-on counter	-
.2	R	UINT-32	Operating Time Moving Operating time in s, the time in which the encoder has moved is output[1)]	-
.3	R	UINT-32	Max. Operating Speed Maximum speed in rpm since the encoder has been in operation	-
.4	R	UINT-32	Starts with Direction Forward Counter for movements of the encoder in forward rotation[1)]	-
.5	R	UINT-32	Starts with Direction Backward counter for starting the encoder in backward rotation[1)]	-
.6	R	UINT-32	Starts with Alternating Directions Counter for starting the encoder in alternating rotation[1)]	-
.7	R	UINT-32	Operating Hours Counter Operating hours counter (× 0.1 h)	-
.8	R	UINT-16	Min. Operating Temperature Minimum operating temperature in °C	-
.9	R	UINT-16	Max. Operating Temperature Maximum operating temperature in °C	-
.10	R	UINT-16	Min. Operating LED Current Minimum internal LED current in µA	-
.11	R	UINT-16	Max. Operating LED Current Maximum internal LED current in µA	-
.12	R	UINT-16	Min. Operating Voltage Minimum supply voltage in mV	-
.13	R	UINT-16	Max. Operating Voltage Maximum supply voltage in mV	-

Object Subindex	Access	Data type	Designation Description	Data values
.14	R	UINT-32	Internal FPGA Revision Number FPGA revision number	-
.15	R	UINT-32	Counter of Diagnosis Storage Counter for the storage processes in the EEPROM	-

3.7 Controls and status indicators

The AFS60/AFM60 EtherCAT® Absolute Encoder has five LEDs.

Three of the LEDs indicate the operational status (NMOD, STAT and Encoder), two the status of the Ethernet interface (L/A1 and L/A2).

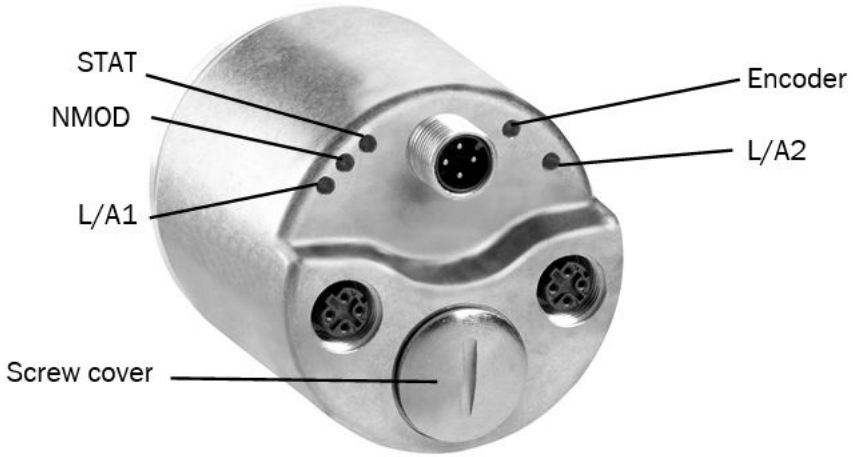


Figure 29: Position der LEDs, der Codierschalter und des Preset-Tasters

The LEDs are multi-colored. see table 91, page 71 see table 92, page 72 show the meaning of the signals.

The preset push-button is under the screw cover.

4 Commissioning

This chapter provides information on the electrical installation, configuration and commissioning of the Absolute Encoder AFS60/AFM60 EtherCAT®.

► Please read this chapter before mounting, installing and commissioning the device.

4.1 Electrical installation

DANGER
Risk of injury from electrical voltage.
Disconnect the system from the voltage supply to prevent the system from starting unintentionally.

► Before starting work on the system, ensure that it is and remains in a de-energized state during electrical installation.

Connecting male and female connectors are required for electrical installation (see data sheet of the absolute encoder).

4.1.1 Connections of the AFS60/AFM60 EtherCAT®

The connections of the AFS60/AFM60 EtherCAT® are on the back.

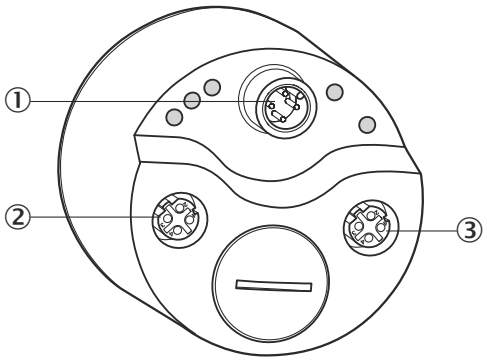


Figure 30: Position of the connections of the AFS60/AFM60 EtherCAT®

① Versorgungsspannung
② Port 1 IN
③ Port 2 OUT

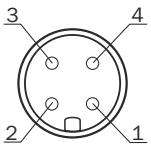


Figure 31: Port 1, Port 2: Female connector, M12, 4-pin

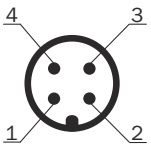


Figure 32: Supply voltage: Male connector, M12, 4-pin

Table 89: Pin assignment for the connection of the supply voltage

P	Signal	Wire color[1]	Function
1	V_s	Brown	Supply voltage 10 ... 30 V DC
2	-	White	Do not use
3	GND	Blue	0 V DC (Ground)
4	-	Black	Do not use

1 On the usage of pre-wired cables.

NOTE

Pin 2 and 4 are **not allowed to be assigned**, otherwise irreparable damage could be caused to the AFS60/AFM60 EtherCAT®.

Table 90: Pin assignment for the connection of Port 1 and Port 2

PIN	Signal	Wire color[1]	Function
1	TxD+	Yellow	Ethernet
2	RxD+	White	Ethernet
3	TxD–	Orange	Ethernet
4	RxD–	Green	Ethernet

1 On the usage of pre-wired cables.

NOTE

- ► **Connect the shielding to the encoder's housing!**
- ► Pay attention to the maximum cable lengths.
- ► Mount all cables with strain relief.

4.2 Settings on the hardware

There are the following controls for making settings under the screw cover:

- three encoding switches
- preset push-button

► Open the screw cover using a screwdriver for slot-head screws with a blade width of min. 10.0 mm.

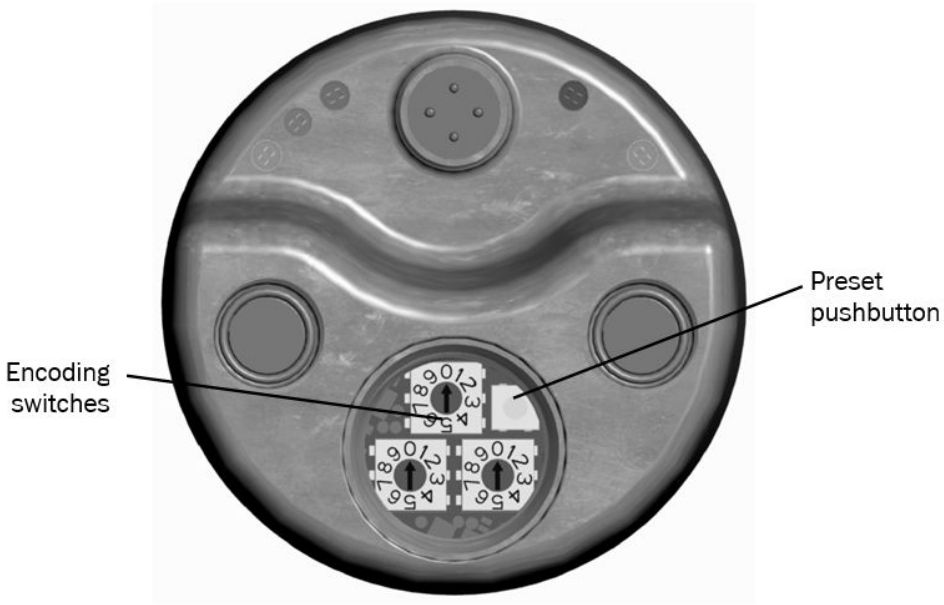


Figure 33: Position of the controls

NOTE

The three encoding switches do not have any function on the AFS60/AFM60 EtherCAT®.

Preset push-button

The preset function is available in every status of the EtherCAT® state machine.

► To trigger the preset, press the preset pushbutton. The value from object 2005h is used as the new position value.

NOTE

- Only set a preset value when the encoder is at standstill.
- The preset value must lie within the measuring range configured.

CAUTION

Before triggering the preset function, check whether there is a hazard from the machine or system in which the encoder is integrated!

The preset function results in a change in the position value output by the encoder. This change could cause an unexpected movement that may result in a hazard for persons or damage to the system or other items.

4.3 Configuration

The AFS60/AFM60 EtherCAT® can be integrated into a Beckhoff control system. For this purpose an ESI file is loaded into the system.

NOTE

- All software notes are displayed in English.
- All software notes are related to the TwinCAT® system manager.

4.3.1 Default delivery status

The AFS60/AFM60 EtherCAT® is supplied with the following parameters:

- Code sequence = clockwise
- Scaling = none
- Resolution per revolution = 262,144
- Total resolution AFS60 = 262,144
- Total resolution AFM60 = 1,073,741,823
- Preset = 0
- Speed measuring unit = rpm
- Round axis functionality = not activated
- Nominator for the number of revolutions (Round axis functionality) = 2,048
- Divisor for the number of revolutions (Round axis functionality) = 1

4.3.2 System configuration

NOTE

All configuration information relates to Beckhoff controllers that are configured and diagnostics undertaken using the configuration tool TwinCAT®.

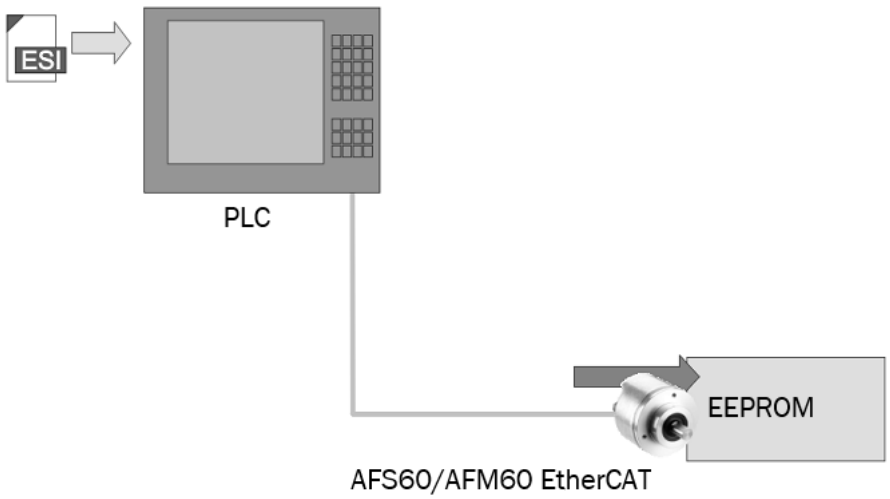


Figure 34: Integration in TwinCAT® with ESI file

- ► Copy the ESI file **SICK-AFx_vX-xxx** in the TwinCAT® directory to the folder **TwinCAT\3.1\Config\Io\EtherCAT**
- ► Then restart the TwinCAT® system manager.
- ► Add the encoder as a box manually (Add New Item) or automatically in the device tree if the encoder is connected to the controller (Scan).

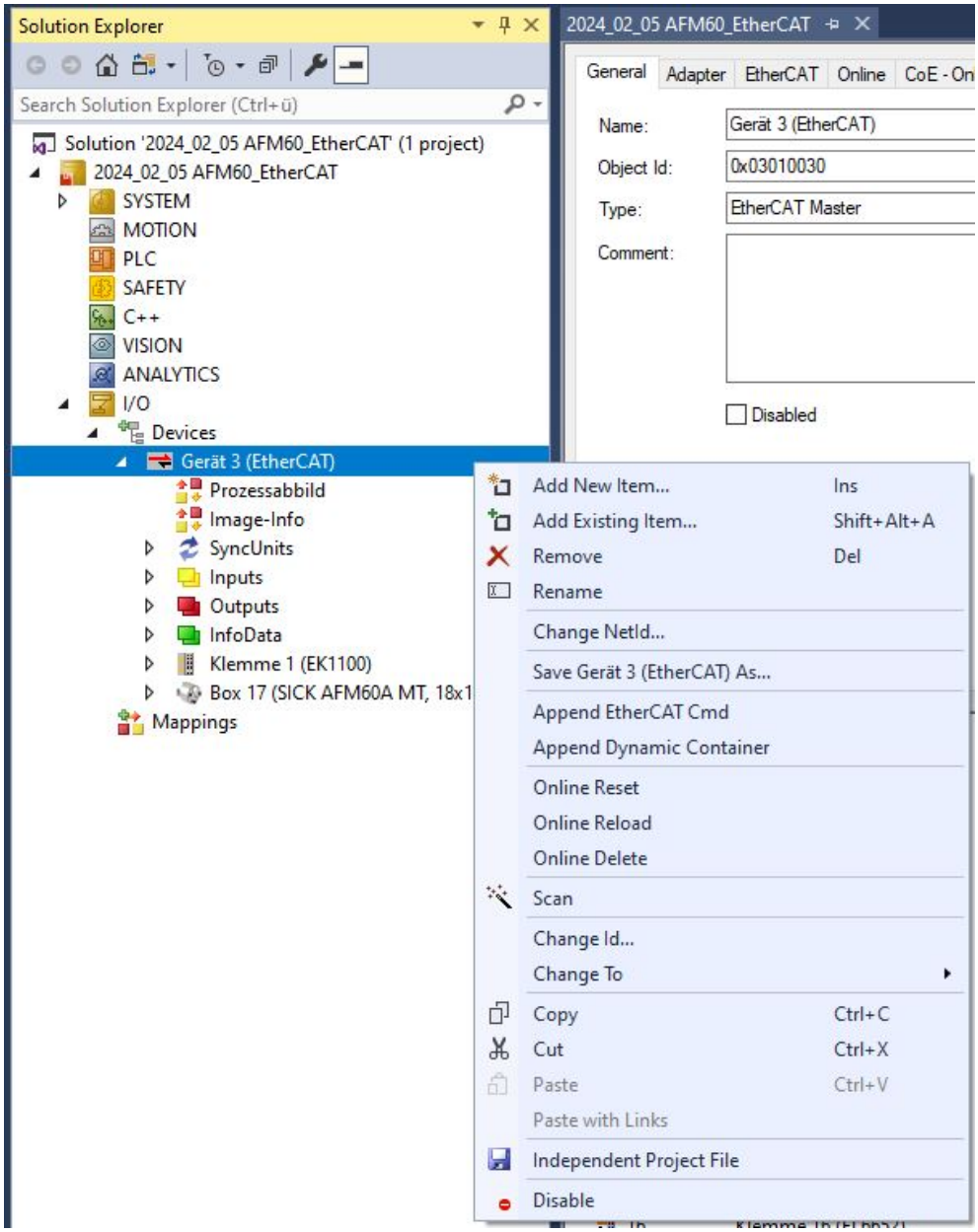


*Figure 35: Context menu command **Append box...***

► Choose the required encoder type under SICK AG. (... MT = Multiturn, ... ST = Singleturn)

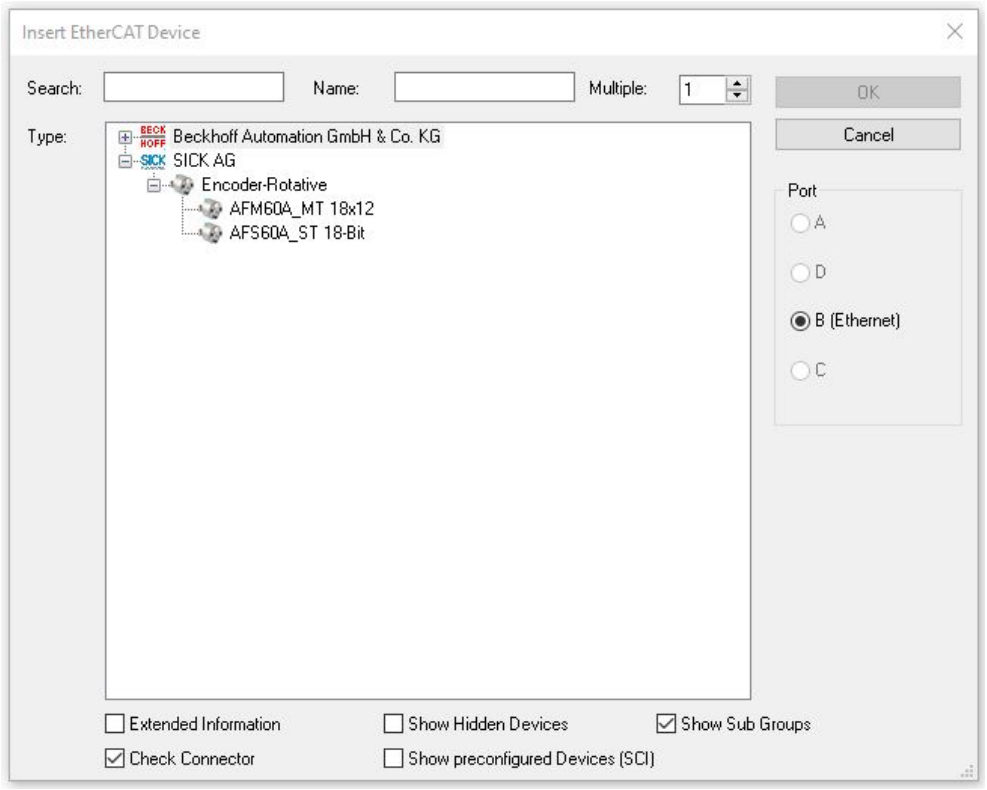


Figure 36: Dialog box for adding an EtherCAT device

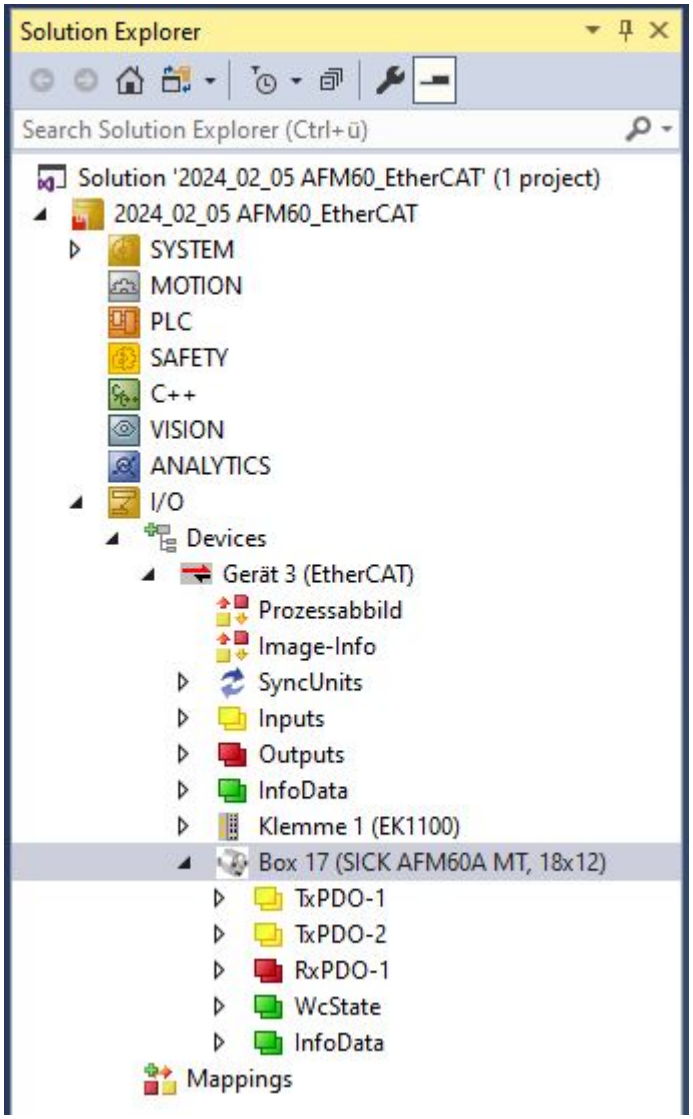


Figure 37: Encoder in the device tree

The encoder is displayed in the device tree as **Box n**.

► Then place the TwinCAT® system manager in the configuration mode.

Figure 38: Configuration mode button

Prompts are displayed as to whether the TwinCAT® system manager is to be placed in the configuration mode, whether the data are to be loaded from the I/O device and whether the system is to be placed in the Free Run operating mode.

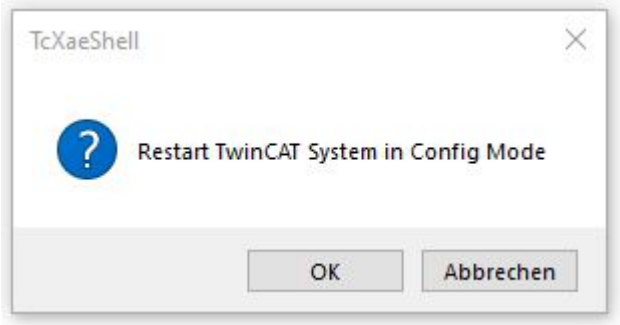


Figure 39: Configuration mode prompt

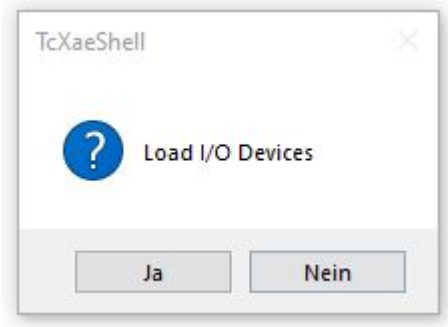


Figure 40: Load I/O Devices prompt

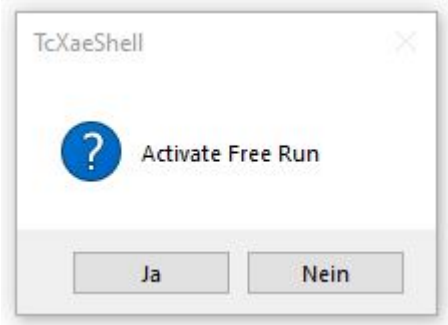


Figure 41: Free Run prompt

► Click **OK** or **Yes**.

Figure 42: Status display of the free run or configuration mode (blue)

Status display of the configuration mode (no cyclical communication) - permanently blue.

Figure 43: Status display of the free run or configuration mode (red)

Status display of free run mode (extension of configuration mode with cyclical data transfer) - alternating blue and red.

The status display is permanently blue in Config mode. In free run mode, the status display alternates between blue and red.

NOTE

The Free Run mode of the TwinCAT® system manager described here should not be confused with the Free Run operating mode of the encoder (see "Object 2004h – Configuration Install Service", page 52).

All object parameters can now be read out or parameterized in the **CoE - Online** tab (see "Configurable functions", page 19).

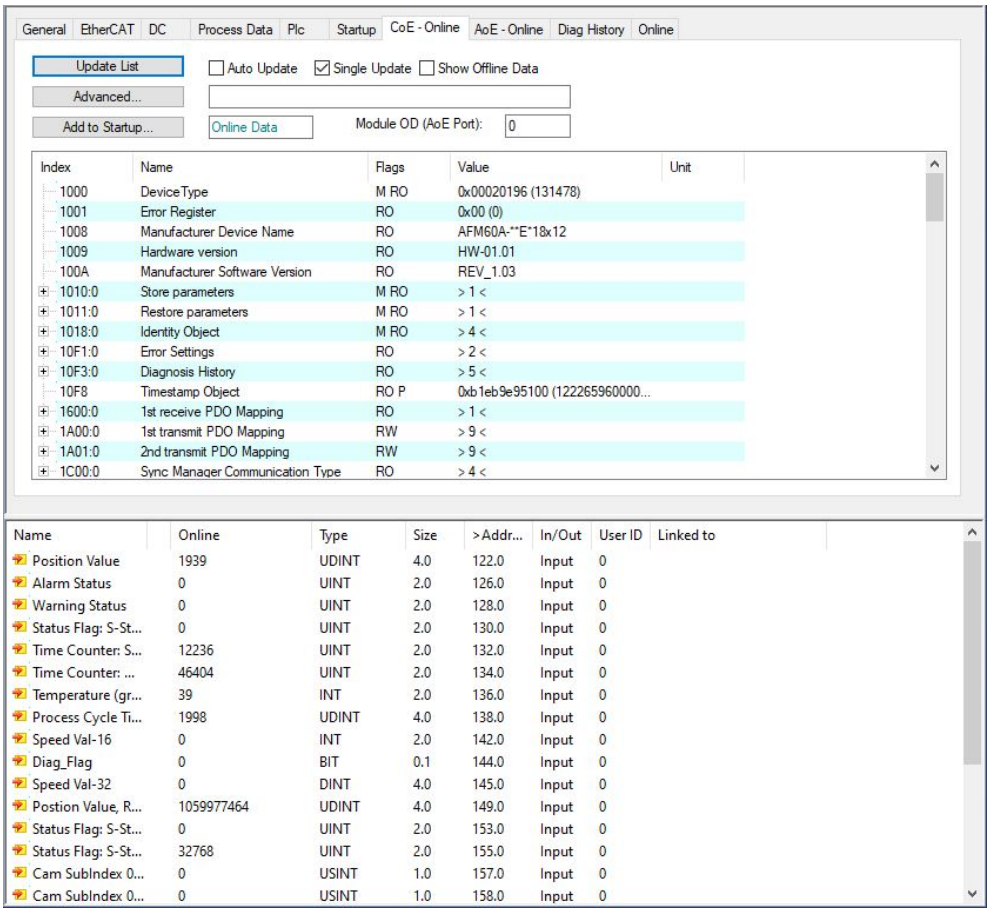


Figure 44: CoE tab - Online

4.4 Test notes

CAUTION

Commissioning requires a thorough check by authorized personnel!

Before you operate a system equipped with the AFS60/AFM60 EtherCAT® for the first time, make sure that the system is first checked and released by authorized personnel. Please read the notes see "", page 8.

5 Troubleshooting

5.1 Response to errors

DANGER
Cease operation if the cause of the malfunction has not been clearly identified!
The machine must be put out of operation if the error cannot be clearly assigned and safely rectified.

5.2 Support

If an error cannot be rectified using the information in this section, contact the responsible SICK representative in your country.

5.3 Error and status indications on the LEDs

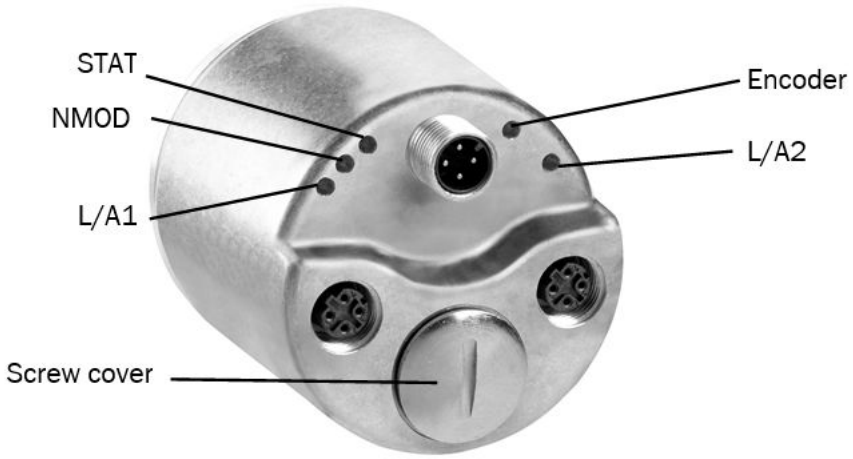


Figure 45: Position of the LEDs

5.3.1 Identification of the encoder

Place the encoder (e.g. in a system with several sensors) in the Pre-Operational status using the TwinCAT® system manager. As a result the STAT status LED flashes green every 200 ms and the encoder can be identified more easily.

5.3.2 NMOD, STAT and Encoder status LEDs

Table 91: Meaning of the status LEDs NMOD, STAT and Encoder

Display	Description
LED NMOD	
○ Off	No supply voltage or Network module not initialized
● Green	Network module in operation
● Red	Error in the network module
STAT LED run status	
Run status (green)	

Display	Description
○ Off	Status Initializing or No supply voltage
☼ 200 ms	Pre-Operational status The encoder is ready for configuration, SDO transfer can take place. Can be used for identification.
☼ 200/1000 ms	Pre-Operational status EtherCAT master reads the position values from the encoder.
●	Operational status EtherCAT master reads the position values from the encoder in real time.
Error status (red)	
○ Off	No error or No supply voltage
☼ 200 ms	Faulty configuration
☼ 200/1000 ms	Local error The encoder has changed the EtherCAT status independently.
☼ 2 × 200/1000 ms	Watchdog time-out
●	Application error
LED Encoder	
Initialization phase	
○ Off	No supply voltage
☼ Red/green	Self-test at power-on
● Green	Initialization complete/no error
☼ Green	Initialization completed incorrectly
Operational status	
● Green	Bus operates correct
☼ Red	Warning due above/below frequency/rotational speed, above/below operating temperature or above/below sensor LED current (see also object 2010h – Sensor Status (see table 76, page 53)
● Red	Alarm due to an EEPROM error or invalid communication with I^2C device (see table 76, page 53
☼ Orange	EtherCAT or CoE-specific communication error (see table 77, page 54)
☼ Green	Cycle time (SM/DC sync event) set for the system <480 µs (see table 77, page 54)

5.3.3 Ethernet Link LEDs L/A1 and L/A2

Table 92: Meaning of the LEDs L/A1 and L/A2

Display	Description
○ Off	No supply voltage or No connection established, internal ESC port closed
● Green	Connection established, internal ESC port open, **no** data transmission active
● Yellow	Interface port locked
☼ Green	Connection established, internal ESC port open, data transmission active

Display	Description
Yellow	Data collisions

5.4 Diagnostics via EtherCAT®

5.4.1 Error types

The following error types can occur:

- encoder-specific errors, caused by the encoder's measuring system
- application protocol-specific (CoE) errors
- network protocol-specific (EtherCAT) error

5.4.2 Encoder specific errors

Encoder-specific errors must be retrieved by the master. The diagnostics messages can be read from the following objects:

- 1F03h – Diagnosis history (see table 21, page 34)
- 6503h – Alarms (see table 51, page 46)
- 6505h – Warnings (see table 55, page 47)
- 2010h – STW-1 – Device Status Word (see table 75, page 53)

NOTE

If a new diagnostics message has occurred, it is indicated via the subindex .4 "Diagnosis Flag" of the object 10F3h. By default this object is transferred cyclically via the process data object 1A01h.

5.4.3 CoE specific errors

In the case of an error during the SDO transfer, a so-called Abort-SDO-Transfer-Request is transmitted with an error code. The following errors are possible:

Table 93: CoE specific errors

Value	Description
05030000h	Toggle bit has not changed
05040000h	SDO protocol time-out
05040001h	Client/server command invalid or unknown
05040005h	Memory too small
06010000h	Object access not supported
06010001h	Read access to an object that can only be written
06010002h	Write access to an object that can only be read
06020000h	Object not present in the object directory
06040041h	The object cannot be mapped in the PDO
06040042h	Number and length of the mapped objects exceed the PDO length
06040043h	General parameter incompatibility
06040047h	General incompatibility in the device
06060000h	Access error due to a hardware error
06070010h	Incorrect data type, length of the service parameters is incorrect
06070012h	Incorrect data type, length of the service parameters too long
06070013h	Incorrect data type, length of the service parameters too short
06090011h	Subindex does not exist
06090030h	Parameter value range exceeded, only on write access

Value	Description
06090031h	Parameter value written too long
06090032h	Parameter value written too short
06090036h	Maximum value is smaller than minimum value
08000000h	Generic error
08000020h	Data can not be transmitted or saved in the application
08000021h	Data can not be transmitted or saved in the application. Reason: local control system
08000022h	Data can not be transmitted or saved in the application. Reason: actual device status
08000023h	Dynamic object directory creation error or object directory does not exist

5.4.4 EtherCAT® specific errors

EtherCAT-specific errors can be transmitted in the following ways:

- Emergency messages
- AL status information
- Sync Manager Watchdog
- Status LED NMOD (see "NMOD, STAT and Encoder status LEDs", page 71)
- Status LED STAT (see "NMOD, STAT and Encoder status LEDs", page 71)

Emergency messages

Emergency messages are automatically transmitted from the encoder to the master. The data transfer is undertaken via the EtherCAT mailbox service.

Structure of the emergency messages

Table 94: Mailbox service with emergency message

Description	Mailbox header	CoE header	Emergency message
Data length	6 byte	2 byte	8 byte

Table 95: Structure of the emergency messages

Byte							
0	1	2	3	4	5	6	7
Emergency error code		Error register	Additional error field (diagnosis information)				
LsB	MsB	-	Diag 0	Diag 1	Diag 2	Diag 3	Diag 4

The emergency messages comprise the emergency error code, the error register and the additional error field.

The emergency error code defines at which transition of the status of the EtherCAT® state machine the error occurred (see table 96, page 75).

The error register defines the status of the EtherCAT® state machine (see table 97, page 75).

The additional error field comprises five bytes (Diag 0 to 4). The **Diag 0** byte indicates the actual error (see table 98, page 75). The values in the bytes **Diag 1** to **Diag 4** are dependent on the code in the byte **Diag 0**. You will find detailed information in document ETG.1006, chapter “ESM Transition Error”.

Error messages via the EtherCAT® state machine

Table 96: Emergency error codes

Emergency error code	Meaning
0000h	No error
A000h	Transition from Pre-Operational to Safe-Operational status was not successful
A001h	Transition from Safe-Operational to Operational status was not successful

NOTE
If an error condition is rectified, a new emergency message is sent with the emergency error code 0000h.

Table 97: Error register

Error register	Meaning
01h	Status of the EtherCAT® state machine = Initializing
02h	Status of the EtherCAT® state machine = Pre-operational
03h	Status of the EtherCAT® state machine = Safe-operational
04h	Status of the EtherCAT® state machine = Operational
05h	SDO write function failed

The value in byte 3 (Diag 0) shows which error has occurred in which Sync Manager:

Table 98: Additional Error Field Byte 3 (Diag 0)

Additional Error Field Byte 3 (Diag 0)	Meaning	
00h	Sync Manager Length Error Invalid length of the Sync Manager addressing.	Sync Manager 0 (Write mailbox)
01h	Sync Manager Address Error An incorrect address is assigned to the Sync Manager.	
02h	PDO Length Error The PDO length is incorrect.	
03h	Sync Manager Settings Error Erroneous configuration of the Sync Manager.	
04h	Sync Manager Length Error Invalid length of the Sync Manager addressing.	Sync Manager 1 (Read mailbox)
05h	Sync Manager Address Error An incorrect address is assigned to the Sync Manager.	
06h	PDO Length Error The PDO length is incorrect.	
07h	Sync Manager Settings Error Erroneous configuration of the Sync Manager.	

Additional Error Field Byte 3 (Diag 0)	Meaning	
08h	Sync Manager Length Error Invalid length of the Sync Manager addressing.	Sync Manager 2 (Process data out)
09h	Sync Manager Address Error An incorrect address is assigned to the Sync Manager.	
0Ah	PDO Length Error The PDO length is incorrect.	
0Bh	Sync Manager Settings Error Erroneous configuration of the Sync Manager.	
0Ch	Sync Manager Length Error Invalid length of the Sync Manager addressing.	Sync Manager 3 (Process data in)
0Dh	Sync Manager Address Error An incorrect address is assigned to the Sync Manager.	
0Eh	PDO Length Error The PDO length is incorrect.	
0Fh	Sync Manager Settings Error Erroneous configuration of the Sync Manager.	

NOTE

The values in the bytes **Diag 1** to **Diag 4** are dependent on the code in the byte **Diag 0**. You will find detailed information in document ETG.1006, chapter “ESM Transition Error”.

Display of an error message in TwinCAT®

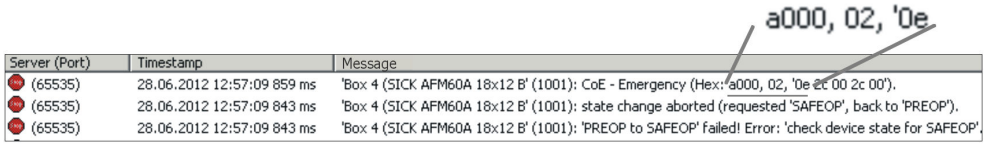


Figure 46: Display of an error message in TwinCAT®

Example:

The example shows a row in the TwinCAT® system manager. The hexadecimal values are to be interpreted as follows:

- A000h: Invalid transition from the Pre-Operational to Safe-Operational status
- 02h: Status of the EtherCAT® state machine = Pre-operational
- 0Eh: The PDO length in Sync Manager 3 is incorrect.

NOTE

The four other values are needed, for instance, for SICK support.

AL status information

Table 99: status information

Value	Designation	Description
0000h	No error	No error
0001h	Unspecified error	Error that cannot be specified
0002h	No memory	More than data memory

Value	Designation	Description
0011h	Invalid requested state change	The requested status change is not valid (e.g. from “Initializing” to “Operational”).
0012h	Unknown requested state	The requested status is unknown or not defined in the state machine.
0013h	Bootstrap not supported	The slave does not support the “Bootstrap” status.
0014h	No valid firmware	The data loaded to the slave are not valid firmware.
0015h	Invalid mailbox configuration	The configuration of the Mailbox Sync Manager is invalid. The error occurred during the bootstrap.
0016h	Invalid mailbox configuration	The configuration of the Mailbox Sync Manager is invalid. The error occurred in the Pre-Operational status.
0017h	Invalid sync manager configuration	The configuration of the Sync Manager is invalid.
0018h	No valid inputs available	The application cannot provide any valid input data.
0019h	No valid outputs available	The application cannot receive any valid output data.
001Ah	Synchronization error	The encoder is not synchronized. It is not possible to define any specific cause of the error.
001Bh	Sync manager watchdog	Error detected by the watchdog. It has not been possible to receive any data or to receive data within the time-out.
001Ch	Invalid sync manager types	-
001Dh	Invalid output configuration	The Sync Manager configuration for output data is incorrect.
001Eh	Invalid input configuration	The Sync Manager configuration for input data is incorrect.
001Fh	Invalid watchdog configuration	The watchdog configuration is incorrect (e.g. if the watchdog is activated, but a time-out is not configured).
0020h	Slave needs cold start	Encoder must be restarted (Power on/off)
0021h	Slave needs “INIT”	The encoder must be set to the “Initializing” status.
0022h	Slave needs “PREOP”	The encoder must be set to the “Pre-operational” status.
0023h	Slave needs “SAFEOP”	The encoder must be set to the “Safe-operational” status.
0024h	Invalid input mapping	The data mapping of the input data does not match the expected mapping.
0025h	Invalid output mapping	The data mapping of the output data does not match the expected mapping.
0026h	Inconsistent settings	General error
0027h	Free Run not supported	The Free Run operating mode is not supported.
0028h	Synchronization not supported	The synchronous operating modes are not supported.
0029h	Free Run needs 3 Buffer mode	-
002Ah	Background watchdog	-

Value	Designation	Description
002Bh	No valid inputs or outputs	-
002Ch	Fatal Sync error	The Sync0 or Sync1 events can no longer be received by the encoder.
002Dh	No sync error	It was not possible for the encoder to receive the Sync0 or Sync1 events during the status change from “Safe-Operational” to “Operational”.
0030h	Invalid DC “SYNC” configuration	The DC configuration is invalid.
0031h	Invalid DC latch configuration	The DC latch configuration is invalid.
0032h	PLL error	Master not synchronized, however at least one DC event has been received
0033h	Invalid DC I/O error	Several synchronization errors possible, no synchronization
0034h	Invalid DC time-out error	Several synchronization errors possible, too many DC events “missed”
0042h	MBX_EOE	-
0043h	MBX_COE	-
0044h	MBX_FOE	-
0045h	MBX_SOE	-
004Fh	MBX_VOE	-
0050h	EEPROM no access	-
0051h	EEPROM error	No access to the EEPROM of the encoder
0060h	Slave restarted locally	-
0061h	Device Identification value updated	The encoder’s identification value has been successfully renewed.
00F0h	Application controller available	-

5.4.5 Error messages

The error messages are output via the object **10F3h – Diagnosis History** (see table 21, page 34).

Table 100: Error messages based on the S_STAT-A flags

Text ID	Flag (type)	Description
115	0002h Error	Memory error: Invalid EEPROM checksum on initialization
114	0002h Error	Position error: Invalid communication with the I²C device in the sensor module
113	0002h Error	Reserved
112	0002h Error	Position error: Invalid EEPROM checksum or Invalid internal SSI communication (MFP4 signal)
111	0002h Error	Position error: Invalid synchronization or no synchronization of MA sensor with the LY singleturn position
110	0002h Error	Position error: The error register in LY is activated (MFP5 signal). or Invalid internal SSI communication (MFP4 signal)

Text ID	Flag (type)	Description
109	0002h Error	Position error: Error on the calculation of the vector length $Sin^2 + Cos^2$ in the multiturn stage
108	0002h Error	Position error: Error on the calculation of the vector length $Sin^2 + Cos^2$ in the singleturn stage
107	0002h Error	Position and memory error: Invalid communication with the I²C device in the main module
106	0002h Error	Position error: Error on the calculation of the amplitude values $Sin^2 + Cos^2$ in the singleturn stage
105	0001h Warning	Warning in relation to the speed: Current measured value outside of the minimum or maximum limit
104	0001h Warning	Position error: Error on the calculation of the amplitude values $Sin^2 + Cos^2$ in the multiturn stage
103	0001h Warning	Warning in relation to the supply voltage: Current measured value outside of the minimum or maximum limit
102	0001h Warning	Warning, sensor LED current critical: Current measured value outside of the minimum or maximum limit
101	0001h Warning	Warning in relation to the temperature: Current measured value outside of the minimum or maximum limit
100	0001h Warning	Warning: General start-up error at power-on

Table 101: Error messages based on the S_STAT-B flags

Text ID	Flag (type)	Description
215	0001h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (Sensor Config Data)
214	0001h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (Device Configuration)
213	0001h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (Diagnosis Process Data Basic)
212	0001h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (Diagnosis/Service Data)
211	0001h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (user configuration parameter or communication mapping)
210	-	Reserved
209	0001h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (user configuration 'CAM' parameter)
208	0001h Warning	Memory error caused by invalid checksum on reading the EEPROM during encoder initialization (user configuration 'Basic xxx' parameter)
207	0001h Warning	Reserved
206	0001h Warning	Cycle time set for the system <480 µs

Text ID	Flag (type)	Description
205	0001h Warning	Reserved
204		Warning, triggered on executing the preset function: The preset value, defined by the scaling parameter, is outside the measuring range (CMR).
203 ... 200	0001h Warning	Warning, occurred on changing or writing parameter values

Table 102: Error messages based on the S_STAT-C flags

Text ID	Flag (type)	Description
315	0000h Information	Information: Encoder in the Free Run operating mode. The formation of the position **is synchronized** with the process data cycle of the master.
314	0000h Information	Information: Encoder in the Synchronous operating mode. The formation of the position **is not synchronized** with the process data cycle of the master.
313	0000h Information	Reserved
312	0001h Warning	Preset function has been triggered and confirmed by object 2000h (see table 67, page 50)
311 ... 304	-	Reserved
303	0000h Information	Status information on saving internal diagnostic data: Save operation requested and operation in progress or Save operation complete
302	0000h Information	Status information on saving internal diagnostic data: Save operation requested and operation in progress or Save operation complete
301	0000h Information	Saving the configuration data using the Save command (see table 15, page 33): Save operation requested and operation in progress or Save operation complete
300	-	Reserved

6 Annex

6.1 Conformities and certificates

You can obtain declarations of conformity, certificates, and the current operating instructions for the product at www.sick.com. To do so, enter the product part number in the search field (part number: see the entry in the “P/N” or “Ident. no.” field on the type label).

6.1.1 EU declaration of conformity

Excerpt

The undersigned, representing the manufacturer, herewith declares that the product is in conformity with the provisions of the following EU directive(s) (including all applicable amendments), and that the standards and/or technical specifications stated in the EU declaration of conformity have been used as a basis for this.

6.1.2 UK declaration of conformity

Excerpt

The undersigned, representing the following manufacturer herewith declares that this declaration of conformity is issued under the sole responsibility of the manufacturer. The product of this declaration is in conformity with the provisions of the following relevant UK Statutory Instruments (including all applicable amendments), and the respective standards and/or technical specifications have been used as a basis.

8015235/1N2H/2024-03-21/en

Australia
Phone +61 (3) 9457 0600
1800 33 48 02 – tollfree
E-Mail sales@sick.com.au

Austria
Phone +43 (0) 2236 62288-0
E-Mail office@sick.at

Belgium/Luxembourg
Phone +32 (0) 2 466 55 66
E-Mail info@sick.be

Brazil
Phone +55 11 3215-4900
E-Mail comercial@sick.com.br

Canada
Phone +1 905.771.1444
E-Mail cs.canada@sick.com

Czech Republic
Phone +420 234 719 500
E-Mail sick@sick.cz

Chile
Phone +56 (2) 2274 7430
E-Mail chile@sick.com

China
Phone +86 20 2882 3600
E-Mail info.china@sick.net.cn

Denmark
Phone +45 45 82 64 00
E-Mail sick@sick.dk

Finland
Phone +358-9-25 15 800
E-Mail sick@sick.fi

France
Phone +33 1 64 62 35 00
E-Mail info@sick.fr

Germany
Phone +49 (0) 2 11 53 010
E-Mail info@sick.de

Greece
Phone +30 210 6825100
E-Mail office@sick.com.gr

Hong Kong
Phone +852 2153 6300
E-Mail ghk@sick.com.hk

Hungary
Phone +36 1 371 2680
E-Mail ertekesites@sick.hu

India
Phone +91-22-6119 8900
E-Mail info@sick-india.com

Israel
Phone +972 97110 11
E-Mail info@sick-sensors.com

Italy
Phone +39 02 27 43 41
E-Mail info@sick.it

Japan
Phone +81 3 5309 2112
E-Mail support@sick.jp

Malaysia
Phone +603-8080 7425
E-Mail enquiry.my@sick.com

Mexico
Phone +52 (472) 748 9451
E-Mail mexico@sick.com

Netherlands
Phone +31 (0) 30 204 40 00
E-Mail info@sick.nl

New Zealand
Phone +64 9 415 0459
0800 222 278 – tollfree
E-Mail sales@sick.co.nz

Norway
Phone +47 67 81 50 00
E-Mail sick@sick.no

Poland
Phone +48 22 539 41 00
E-Mail info@sick.pl

Romania
Phone +40 356-17 11 20
E-Mail office@sick.ro

Singapore
Phone +65 6744 3732
E-Mail sales.gsg@sick.com

Slovakia
Phone +421 482 901 201
E-Mail mail@sick-sk.sk

Slovenia
Phone +386 591 78849
E-Mail office@sick.si

South Africa
Phone +27 10 060 0550
E-Mail info@sickautomation.co.za

South Korea
Phone +82 2 786 6321/4
E-Mail infokorea@sick.com

Spain
Phone +34 93 480 31 00
E-Mail info@sick.es

Sweden
Phone +46 10 110 10 00
E-Mail info@sick.se

Switzerland
Phone +41 41 619 29 39
E-Mail contact@sick.ch

Taiwan
Phone +886-2-2375-6288
E-Mail sales@sick.com.tw

Thailand
Phone +66 2 645 0009
E-Mail marcom.th@sick.com

Turkey
Phone +90 (216) 528 50 00
E-Mail info@sick.com.tr

United Arab Emirates
Phone +971 (0) 4 88 65 878
E-Mail contact@sick.ae

United Kingdom
Phone +44 (0)17278 31121
E-Mail info@sick.co.uk

USA
Phone +1 800.325.7425
E-Mail info@sick.com

Vietnam
Phone +65 6744 3732
E-Mail sales.gsg@sick.com

Detailed addresses and further locations at **www.sick.com**

SICK AG | Waldkirch | Germany | www.sick.com

SICK
Sensor Intelligence.